

Lower Eastern Shore Conservation and Restoration Action Strategy

A photograph of a sailboat on the water at sunset. The sun is low on the horizon, creating a bright orange glow and reflecting on the water. The sailboat is in the foreground, with its sails partially visible. The sky is a mix of orange and blue.

*Program Description
& Atlas of Indicators*

**Lower Eastern Shore
Conservation and Restoration
Action Strategy**

**PHASE I:
PROGRAM DESCRIPTION AND
ATLAS OF ENVIRONMENTAL INDICATORS**

Prepared by
Maryland Department of Natural Resources
Chesapeake and Coastal Watershed Service
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Lower Eastern Shore Conservation and Restoration Action Strategy

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Introduction, Purpose, and Approach

This regional effort to look in detail at the water quality and living resource issues in Maryland's Lower Eastern Shore, and the programs available to deal with them, arises from a federal initiative launched in 1998. It also builds on many years' work by Maryland State and local governments and private interests to deal with the degradation of the Chesapeake Bay and to restore it to health and productivity. It represents a continued broadening of interest from water pollution alone to whole ecosystem health, from the Bay by itself to its tributary streams, from the water column to the watersheds that determine most of what is found in the water column. This report is part of a continuing process of assessing problems and causes, identifying opportunities for intervention, implementing corrective actions, and evaluating how well our environmental goals are being achieved.

Clean Water Action Plan

Following the lead of a number of states doing watershed-based restoration work, in early 1998, the federal Environmental Protection Agency issued the Clean Water Action Plan (CWAP) calling for a broadened approach to dealing with the nation's water quality and related natural resource issues. While not arising from any specific section of evolving federal clean water legislation, the CWAP represents an effort to weave together several on-going processes to achieve a watershed-based, better-targeted allocation of monetary and other resources devoted to improving the condition of the nation's waters. Some additional funds were made available under existing federal programs to help accelerate implementation of needed restoration actions.

States were invited to respond to the Clean Water Action Plan by developing, first, a Unified Watershed Assessment, to be followed by Watershed Restoration Action Strategies for localized areas in order to enable the expenditure of the added funds for projects in identified priority areas. The Unified Watershed Assessment in Maryland examined existing information, structured as several indicators of watershed condition or stress, to determine water quality and living resource conditions at the Maryland "8-digit" watershed scale—the name is based on the number of digits in the identifier code for the watershed. There are 134 of these watersheds statewide in Maryland, averaging roughly 75 square miles in size.

One outcome of the Unified Watershed Assessment was the assignment of each watershed to one of three categories (a fourth was not applicable in Maryland): 1) watersheds in need of restoration; 2) watersheds needing protection to maintain current good conditions; and 3) watersheds having pristine conditions or very highly valued natural resources. Because even the 8-digit watershed covers a fairly large geographic area, it is possible for a watershed to be categorized as both 1 and 3; seventeen watersheds were thus characterized in Maryland.

Watershed Restoration Action Strategies are required by CWAP for watersheds characterized as falling into Category 1 in the Unified Watershed Assessment. These strategies are to detail the most important causes of water quality and related natural resource degradation and the measures necessary to correct them. Existing strategies and plans can be the basis for this assessment and targeting effort, under federal guidelines. As discussed below, Maryland has had a history of developing strategies to address, in particular, nutrient pollution in the large basins within the drainage of the Chesapeake Bay; one of these basins is the Lower Eastern Shore Tributary Basin.

Tributary Strategies

Maryland had an on-going structure and approach to dealing with water quality and related natural resource problems prior to initiation of the Clean Water Action Plan: the interstate-federal Chesapeake Bay Program covers virtually the entire State. The Coastal Bays watershed, as part of the National Estuary Program, is also part of a special, holistic approach to water quality improvement and habitat protection and enhancement.

As a response to the needs of the Chesapeake Bay Program, the Governor in 1995 appointed Tributary Strategy Teams in each of ten large basins to develop particular means to carry out a 40% reduction of loadings of nitrogen and phosphorus to the Bay. These nutrients had been determined to be the key pollutants needing reduction in order to restore Bay health. Targets for the reductions were established for each of the ten Tributary Basins through implementation of a number of practices, as detailed in Table 1 for the Lower Eastern Shore Basin.

Table 1
Lower Eastern Shore Implementation Targets

Practices	Targets to be Accomplished by 2000	Accomplished as of 1998
<i>Wastewater Treatment Plants</i>		
Biological and Chemical Nutrient Removal	7 plants	5 agreements signed
<i>Developed Land</i>		
Erosion and Sediment Control	447 acres	245 acres
Enhanced Stormwater Management	3,126 acres	1,298 acres
Stormwater Management Retrofits	219 acres	0

Practices	Targets to be Accomplished by 2000	Accomplished as of 1998
Stormwater Management Conversion	211 acres	0
Septic Tank Pumping	119 systems	?
Septic System Denitrification	0	0
Septic System Connections to Sewer	415 systems	643 systems
Urban Nutrient Management	665 acres	?

Agricultural Land

Soil Conservation and Water Quality Plan Implementation and Treatment of Highly Erodible Land	87,500 acres	115,623 acres
Conservation Tillage	50,000 acres	49,423 acres
Retirement of Highly Erodible Land	0	2 acres
Animal Waste Management Systems—Livestock	2 systems	1 system
Animal Waste Management Systems—Poultry	320 systems	296 systems
Runoff Control	0 systems	1 system
Stream Protection with Fencing	0 acres	0
Stream Protection without Fencing	0 acres	0
Nutrient Management Plan Implementation	83,000 acres	186,216 acres
Cover Crops	31,000 acres	11,883 acres*

Resource Protection and Watershed Planning

Forested Buffers	180 acres	153 acres
Grassed Buffers (Agricultural Land)	0 acres	0

Practices	Targets to be Accomplished by 2000	Accomplished as of 1998
Structural Shore Erosion Control	6,000 linear feet	5,639 linear feet
Nonstructural Shore Erosion Control	9,000 feet	1,845 linear feet
Forest Conservation	806 acres	638 acres
Tree Planting	1,530 acres	341 acres
Forest Harvesting Practices	3,552 acres	?
Installation of Marine Pump-outs	5 marinas	9 marinas

* This is implementation in 1998 only, not cumulative as for other practices.

Data from Tributary Strategies Workgroup Tracking Subcommittee and DNR's Chesapeake and Coastal Watershed Service.

What is not specified in the strategies developed for each Tributary Basin is the geographic allocation of the practices called for—where, specifically, would they be most effective if implemented? Also, the strategies initially focused on water quality improvements, through nutrient reductions, and did not focus on aquatic or riparian habitat issues. Since the inception of the Tributary Team approach, the Teams have decided to include habitat concerns in their efforts. The Unified Watershed Assessment of the Clean Water Action Plan and further assessment as required for a Watershed Restoration Action Strategy provide a vehicle for Tributary Teams to build an integrated approach to help answer these questions.

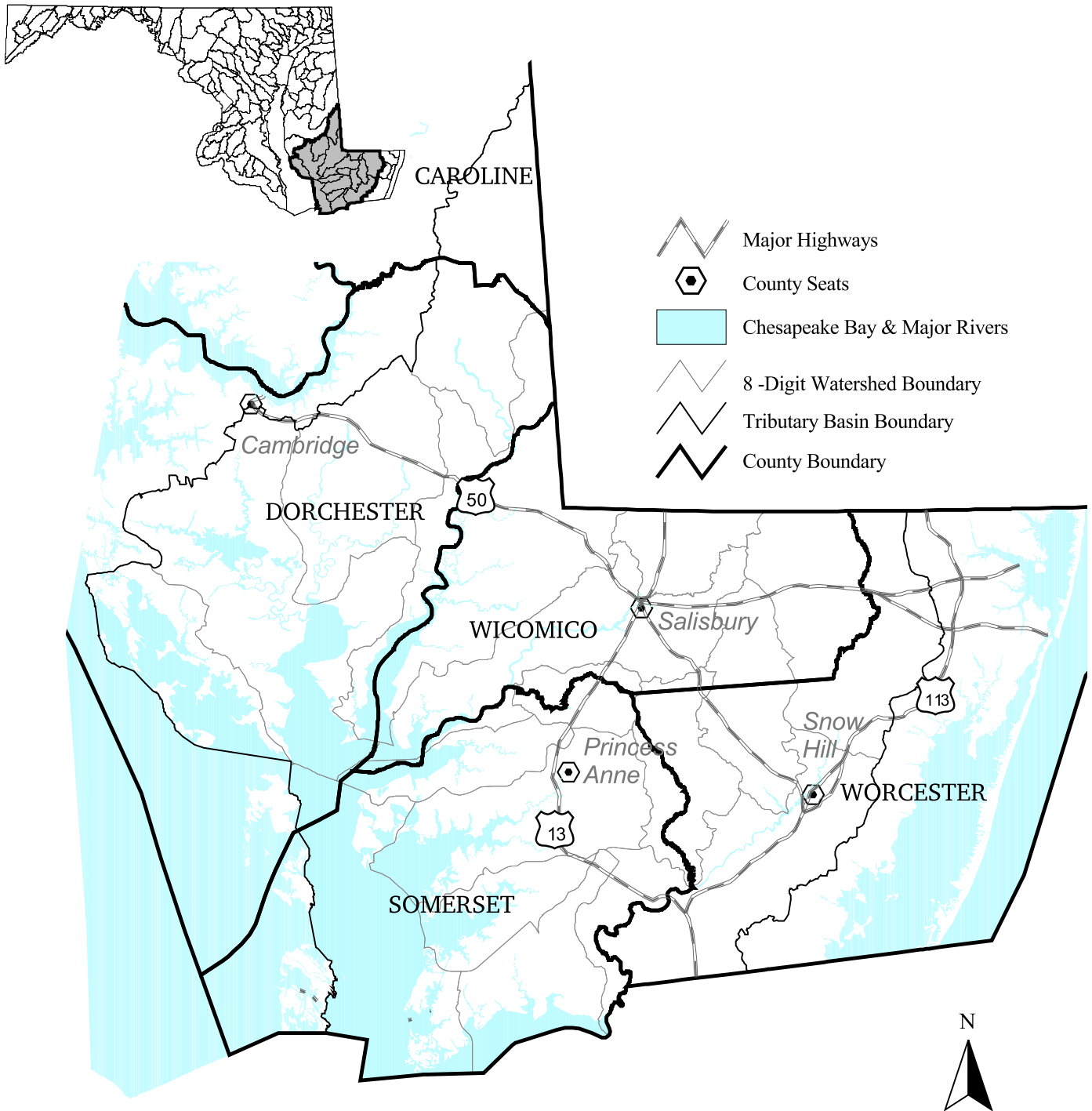
The Unified Watershed Assessment and the Lower Eastern Shore

The Lower Eastern Shore Tributary Basin drains all or part of five counties: Caroline, Dorchester, Somerset, Wicomico and Worcester. Major river systems in the Basin include the Nanticoke, Transquaking, Wicomico, Pocomoke, Manokin, and Big Annemessex; other watersheds consist largely of major tidal wetlands. The watersheds, major towns and transportation arteries are depicted on the map facing.

The Lower Eastern Shore has been for several years a focus of attention for Maryland's state agencies, particularly since the outbreak of *Pfiesteria piscicida* in 1997. The area not only has some of the more intractable water quality problems in the State; it also contains much of the most productive agricultural area and many of the State's unique or best-loved natural resources.

The state has had a long-standing commitment to maintaining the viability of agriculture in this region, as well as to protecting its natural resources. The interest for the Department of Natural

Maryland's Lower Eastern Shore Tributary Basin



Prepared by: Maryland Department of
Natural Resources - 1999

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Resources centered on how natural resources management could be improved in this region by looking at conservation as well as restoration opportunities, and by concentrating multiple programmatic resources in targeted areas within the larger region. Because of the Clean Water Action Plan's emphasis on restoration, the need to restore degraded conditions receives greater attention in this initial Strategy, however conservation opportunities are noted throughout the following discussion of indicators applied to the Lower Eastern Shore.

To determine whether a watershed should be assigned to Category 1 (in need of restoration), the Unified Watershed Assessment used two decision rules:

- A watershed that was on the statewide listing of impaired waters, required under Title 3 of the Clean Water Act, was *de facto* considered to be in Category 1.
- Watersheds failing two or more of the 17 indicators intended to reflect other natural resources goals were classified as Category 1. Failing an "other natural resources" indicator was defined as not meeting an established benchmark (where there is one) or as falling within the "worst" 25 % of watersheds statewide in scores for that indicator

Of the Lower Eastern Shore watersheds, only the Big Annemessex and Fishing Bay watersheds did not meet the first criterion; all of the Lower Eastern Shore watersheds met the second.

The Unified Watershed Assessment went on to establish priorities among the Category 1 watersheds, identifying those which most needed restoration action. These were defined as watersheds that failed on at least half of the natural resource indicators, with some additions because of the severity of degradation or the availability of additional information obtained during the public comment period. Six Lower Eastern Shore watersheds were identified as "priority restoration watersheds": Lower Pocomoke, Upper Pocomoke, Manokin, Lower Wicomico, Wicomico River Head and Transquaking. Finally, one Lower Shore watershed, the Lower Pocomoke, was classified both as a priority restoration watershed and as a selected Category 3 watershed, meaning it had four or more indicators scoring high on possession of significant natural values.

Toward an Action Strategy for the Lower Eastern Shore

This report presents Phase I of a Conservation and Restoration Action Strategy for Maryland's Lower Eastern Shore Tributary Basin. It continues the type of comparative assessment carried out statewide, focusing on a smaller region—17 watersheds—and adding additional indicators of watershed condition which address some of the issues and opportunities specific to this area. Some indicators used in the statewide assessment were not used in the regional examination because they were not applicable or lacked a sufficient number of data points to be reliable indicators for the Lower Eastern Shore.

A Steering Committee consisting of several members of the Tributary Team and additional interested representatives of state and local government, industry, and non-profit organizations was convened to oversee the watershed analysis and to assist with the process of narrowing the focus, from statewide to tributary basin to 8-digit watershed to subwatersheds where on-the-ground projects might be initiated. The Steering Committee also brainstormed issues specific to the Lower Eastern Shore to guide the analysis, and its members were asked to supply information on existing State, local and private programs and their effectiveness.

Based on preliminary evaluation of the comparative assessment, three watersheds were selected by the Steering Committee as the focus for initial detailed examination. Following this, four of the indicators, for which finer-scale data were felt to be valid, were used to assess the comparative condition of smaller sub-watersheds (called “12-digit watersheds” because of the number of digits used in their identifier codes) in these three watersheds. Three of these subwatersheds will be assessed in the field and by other intensive methods, including forums for local participants, as Phase II is carried out to identify specific restoration projects for implementation.

The following pages detail the comparative assessment of the watersheds in the Lower Eastern Shore Tributary Basin. Thirty-one indicators were used in the assessment. To help them to tell a story about what is occurring in the region, the indicators have been grouped into themes that parallel other work being carried out in the State, specifically the Environmental Performance Partnership process in which DNR, the Department of the Environment (MDE), the U.S. Environmental Protection Agency (EPA) and, to a lesser extent, the Maryland Department of Agriculture (MDA) and Maryland Office of Planning (OP) take part.

Goals for Watershed Conservation and Restoration

Maryland’s Environmental Performance Partnership Agreement (EnPA) includes a status report on environmental indicators, organized around a number of goals intended to protect public health, promote ecosystem health, and improve the interface of environmental programs with the public. The Ecosystem Health goals from EnPA guide the development of this Conservation and Restoration Action Strategy as well:

- Improve and protect surface water quality
- Improve and protect the water quality of the Chesapeake Bay
- Conserve natural ecological communities
- Maintain viable populations of native species
- Maintain natural ecological and evolutionary processes
- Ensure adequate protection and restoration of Maryland’s wetlands resources
- Maintain Maryland’s natural resource land base
- Reduce sprawl/encourage smart growth

These goals and the statewide summary indicators related to them are documented in *Maryland's Environmental Indicators, A Status Report*, initially developed in 1997 and revised and reissued in the summer of 1999. For some of the goals, or the indicators associated with them, there are numeric benchmarks, although they reflect statewide targets and are not specific to smaller geographic areas. Examples include re-establishing 600 miles of riparian forest buffer by 2010; creating or restoring 60,000 acres of wetlands; and increasing acreage of submerged aquatic vegetation to approximately 61,700 acres by 2005. For most of the indicators, however, there are no such agreed-upon numeric benchmarks; in many cases the science has not been developed sufficiently to support them.

We anticipate that in Phase II of the Action Strategy, as specific cause-effect material is developed and specific corrective actions are put forward, more numeric benchmarks will be developed in order to gauge progress.



Water Quality/Nonpoint Source Pollution

Maryland's water quality standards provide that surface waters should be protected for basic water uses such as water contact recreation; fishing; support of balanced and diverse populations of aquatic plants, animals and wildlife; and use as an agricultural and industrial water supply. For some defined uses, including shellfish harvesting, water quality conditions must be even higher. Waters that do not meet their designated uses represent a loss of a common resource that could result in economic and societal impacts and threaten human and ecosystem health.

Since passage of the 1972 Clean Water Act, great strides have been made in reducing or eliminating the discharge of pollutants from industries and municipal wastewater treatment systems—point sources of pollution to the Bay and its tributary rivers. However, nutrients and bacteria from point and nonpoint source pollution still pollute much of the State's surface water, affecting aquatic life and limiting uses of these waters. An estimated 55-74% of nutrient inputs to the Bay system are contributed by nonpoint sources, including contaminated runoff from urban areas, runoff from agricultural land uses, nutrient-enriched ground water, and deposition from the atmosphere. These sources are more complex and more difficult to control than point sources.

Stressors and Sources

Over the past 25 years, developing science has pointed more and more to the nutrients nitrogen and phosphorus as the pollutants of primary concern for the Chesapeake Bay system. This concern is based upon nutrient enrichment's broad ecological impacts more than on the public health issues associated with earliest pollution abatement efforts. Excessive nutrient loading causes rapid, uncontrolled growth of algae in surface water. These algal blooms cloud the water and block sunlight, which causes Bay grasses to die. When algae die and sink to the bottom water, decomposition of the resulting organic matter uses oxygen; if too much oxygen is used for decomposition, oxygen levels drop to the point that living resources are stressed or excluded. In yet another insult to water quality, chemical contaminants from both point and nonpoint sources can have sublethal chronic effects including accumulation in tissue and concentration through the food web, and can cause cancer and behavioral abnormalities in aquatic organisms.

In recent years particular attention in the Lower Eastern Shore area has focused on the part excessive nutrients play in the stimulation of toxic forms of the organism *Pfiesteria piscicida*, which have played a role in both fish kills and human health problems. Although major progress is being made in identifying *Pfiesteria* in water samples, and monitoring of both water quality and fish health has been intensified, many questions remain as to the causative mechanisms linking nutrients to outbreaks of *Pfiesteria*.

Lower Eastern Shore Issues

The Steering Committee for the Lower Eastern Shore Conservation and Restoration Action Strategy identified a number of particular issues which were of concern in dealing with water quality and nonpoint source pollution in the basin. Other issues have been identified by the Lower Eastern Shore Tributary Strategy Team.

- Stormwater management and related sediment and erosion problems, from a variety of sources: urban areas (including industrial and commercial area parking lots), agricultural lands, and roads. The issue includes the need for retrofitting existing developed areas.
- Animal waste management, especially poultry waste.
- Human waste management, including problems created for both surface and ground water by septic tank usage, the relationship between septic tank usage and smart growth concerns, and the adequacy of existing wastewater treatment plants to handle both sewered areas and seepage.
- Ground water contamination, from the perspectives both of what is causing it and of the need to protect public and private drinking water sources.
- Regulatory requirements for septic systems and their relationship to the development process, particularly with respect to sprawl.
- Erosion and sediment control, including the effects of sea-level rise.

Management Programs

A variety of State programs, and a few at the local level, have developed over the years to address water quality, and the interstate Chesapeake Bay Program—involving the Federal government as well as the States of Maryland, Virginia and Pennsylvania and the District of Columbia—has for a number of years served to focus attention and funding on the broad spectrum of issues related to the Bay's water quality and living resources. Three State departments—Agriculture (MDA), Environment (MDE) and Natural Resources (DNR)—share responsibility for these programs. In some cases, local governments implement or oversee State programs in their respective jurisdictions. Several of the programs in the Department of Natural Resources are carried out in support of the broader Chesapeake Bay Program. At the federal level, the Natural Resource Conservation Service of the US Department of Agriculture, the US Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), US Geological Survey (USGS) and Fish and Wildlife Service support the program. Local Soil Conservation Districts and local health departments also play important roles in controlling pollution and managing for water quality.

Many of the programs dealing with water quality are regulatory in nature, focusing on controlling pollution from one source or another:

- ***Discharge Permits*** (MDE) establish discharge limits on pollutants from industries and from sewage treatment plants serving residential and commercial development. There are no industrial discharges and 24 municipal wastewater treatment plants permitted in the Lower Eastern Shore Tributary Basin.
- ***Industrial Pretreatment*** (MDE) requirements are established for industries which discharge wastes into municipal treatment systems.
- ***Nutrient Management Program*** (MDA) helps individual farmers plan nutrient management of animal waste, sludge, and commercial fertilizers, as mandated by the Water Quality Improvement Act of 1998 . It trains, certifies, and licenses persons who provide this service.
- ***Pesticide Regulation and Applicator Certification Program*** (MDA) requires licenses for all businesses engaged in commercial pesticide applications or recommendations. Each business must employ at least one Certified Commercial Applicator or Pest Control Consultant.
- ***Septic System Regulations*** (MDE, local health departments) govern the installation of septic systems for sewage handling on individual properties. New requirements have been proposed by the Governor for nitrogen management in new and replacement septic tanks in particular areas.
- ***Total Maximum Daily Loads (TMDLs)*** (MDE) is an approach to determining the upper limit of pollutants that can be discharged to a particular body of water without violating water quality standards.
- ***Critical Area Program*** (DNR-CAC) limits the amount of impervious surface allowed in portions of the Critical Area designated as “limited development” or “resource conservation” areas and requires that stormwater pollutant loadings must be reduced by 10% of pre-development loadings in “intensely developed” areas.

Several programs are available to provide financial assistance to local governments, public utilities and to individual citizens or organizations, including individual farm operators:

- ***Environmental Quality Incentives Program (EQIP)*** (NRCS) provides farmers with cost-sharing and incentive payments for a variety of best management practices designed to improve water quality and enhance wildlife habitat.
- ***Coastal Nonpoint Source Program*** (DNR) focuses on controlling nonpoint source pollution in the coastal zone area by support and implementation of 56 management measures. These measures, which range from agriculture to roads, highways and bridges, are designed to improve water quality. If the measures do not adequately improve water quality, the state is directed to design and implement additional measures.
- ***Clean Lakes Program*** (DNR) is currently not funded.
- ***Statewide Nonpoint Source Management Program*** (DNR) provides reimbursable grants to state and local governments, non-profit organizations and institutions of higher learning to implement nonpoint source pollution control projects.

- ***Chesapeake Bay Implementation Grant Program*** (DNR) assists the states, public or nonprofit entities, and individuals to conduct research, experiments, investigations, training, demonstration, surveys, or studies related to pollution reduction and the improvement of living resources in the Chesapeake Bay. The Chesapeake Bay Program awards grants to reduce and prevent pollution and to improve the living resources in the Chesapeake Bay.
- ***Section 319 Nonpoint Source Grants*** (DNR) are provided under the Federal Clean Water Act for program development and implementation of controls for nonpoint pollution sources. Under the Clean Water Action Plan, a portion of the grant funds can be provided only to implement projects in watersheds classified as Category 1 in the state's Unified Watershed Assessment.
- ***Coastal Zone Management Grant Program*** (DNR) Funds are available to support projects such as coastal wetlands management and protection; natural hazards management; public access improvements; reduction of marine debris; assessment of the impacts of coastal growth and development; special areas management planning; regional management issues; and demonstration projects with the potential to improve coastal zone management.
- ***Marine Pumpout Program*** (DNR) provides grants to individual marinas to install facilities for pumping out the wastewater holding tanks required to be installed on recreational boats. In the Lower Eastern Shore Basin, 17 marinas have participated in the program.
- ***Maryland Agricultural Water Quality Cost-Share Program (MACS)*** (MDA, SCD) provides cost-share to farmers who implement best management practices, including buffers and filter strips to prevent or remedy nonpoint source water pollution.
- ***Biological Nutrient Removal Program (BNR)*** (MDE) offers a means to implement the Chesapeake Bay Agreement's nutrient reduction strategy for point sources through 50% cost-share funding of BNR upgrade at all municipal wastewater treatment plants that have a design flow of 500,000 gallons or more per day. In the Lower Eastern Shore Basin nine plants are targeted for the BNR upgrade.
- ***Water Quality Revolving Loan Fund*** (MDE) provides low interest loans to local governments or a person for water quality improvements projects. Most of the projects funded through this program include the upgrade and expansion of existing wastewater treatment plants, correction of inflow and infiltration problems, and sewage collectors, interceptors and pumping stations. Other types of projects include pretreatment facilities and the capping of closed landfills.
- ***Supplemental Assistance Program*** (MDE) provides grant assistance to help fund projects which MDE has determined are needed to address a public health or water quality problem such as connection of older, established communities with failing septic systems to public sewers, and correction of system deficiencies such as combined sewer overflows, excessive inflow and infiltration (I/I) or antiquated pump stations.

- ***Stormwater Pollution Control Program*** (MDE) provides financial assistance to local governments for the implementation of stormwater management retrofit and conversion projects, as means of controlling the load of nutrients and pollutants entering the State's waterways from older, existing developed areas.
- ***Conservation Reserve Program/Conservation Reserve Enhancement Program*** (NRCS, MDA, SCD, DNR) provides rental payments and incentive payments to farmers to take sensitive lands out of production and to install improved cover. The intent is to reduce erosion and sedimentation to improve water quality and to enhance fish and wildlife habitat.
- ***Critical Area Program*** (DNR-CAC) provides grants to local governments to implement local critical area programs.

Finally, there are miscellaneous voluntary programs or programs oriented to improving the scientific basis for further decision-making:

- ***Pfiesteria Technical Workgroup*** (DNR, MDE) is working on an intensified data gathering and analysis approach to better understanding of the underlying causes and triggering mechanisms behind outbreaks of the toxic forms of this dinoflagellate microorganism that caused significant fish and human health effects in 1997.
- ***Clean Marina Initiative*** (DNR) promotes voluntary adoption of measures to prevent pollution from marinas and recreational boats. Two marinas in the Lower Eastern Shore Tributary Basin have signed pledges to seek certification as "Clean Marinas" within a year.
- ***Shore Erosion Program*** (DNR) provides assistance for the design, construction, management and financing of non-structural streambank or shoreline erosion control projects. Such projects address major contributors of sediment to the State's waters.
- ***Paired Watershed Project*** (DNR) has undertaken an intense implementation and monitoring effort designed to demonstrate the effect on water quality of eliminating Phosphorus inputs and implementing cover crops on all available cropland. The project compares two watersheds with similar land use and farming practices: a control watershed, in which farming practices remain unaltered, and a treatment watershed in which BMPs will be implemented. They will be compared to determine changes to instream nutrient concentrations and loads.
- ***Agricultural Nutrient Management Program*** (MDA, MDE, Extension Service) provides nutrient planning services to Maryland farmers via a network of nutrient management advisors located in all county Extension office. The program is a component of the Maryland Nutrient Management Program.

Local governments implement, or help to implement, a number of the State programs dealing with water quality issues. For example, determination of the suitability of a potential building

site for on-site (septic tank) waste disposal is a local responsibility, following State guidelines. Other programs are more locally-focused, although most are still carried out under requirements of State plans or regulations.

- ***Water and Sewer Plans***, detail where community (as opposed to individual, on-lot) water supply and wastewater management services are, or are planned to be, provided.
- ***Stormwater Management Ordinances*** require site plans and calculations of amounts of runoff, as well as steps to control this source of nonpoint source pollution.
- ***Ground Water Protection Plans*** have been developed by some Lower Eastern Shore counties to identify areas where differing conditions require different treatment for septic systems.
- ***Erosion and Sediment Control*** requirements for building sites are established in county regulations and are reviewed by local Soil Conservation District personnel along with stormwater management practices.
- ***Critical Area Program*** requires local governments and municipalities to ensure land use practices conform to certain requirements within 1000 feet of tidal waters.



Program Issues and Observations

Both local and State government environmental practitioners reviewed the programs for which they are responsible to identify what is or is not working well with these programs—where there were problems that interfered with their ability to undertake action to address water quality problems. Important conclusions from this review include the following:

- ✓ Staff in the programs is spread so thin that there are inadequacies in monitoring, in inspections and follow-up for plan implementation, in carrying out plan and project review.
- ✓ There is a lack of funding for relief of septic tank failures or dealing with situations where human waste management is even more primitive. Frustration was expressed on the part of local government program managers that their codes did not allow for alternative septic system implementation (e.g. shared systems) which would create more open space and clustered development.
- ✓ State regulatory and enforcement back-up or support for local efforts is lacking, often because local projects are deemed too small for State intervention, given staffing levels and apparent magnitude of the local impacts. New State regulations for septic tanks and for stormwater management were both anticipated but not promulgated.
- ✓ State regulations for ground water-penetrating septic systems are needed to support local efforts.
- ✓ There is need for greater coordination between the Water Management Administration and the Waste Management Administration of MDE with regard to handling septage from septic tank pumping programs.
- ✓ Limitations in what some programs covered were viewed as a handicap for overall program effectiveness. For example, the MACS program does not share costs for sediment control ponds in the Lower Eastern Shore area due to program requirements that eliminate low-slope areas from funding consideration. Managers felt that adding water quality considerations into the formula for funding determinations would help greatly. MACS also does not-cost share water control structures that may help to trap sediments and stabilize the grades of drainage ditches, or shallow water impoundments which benefit both water quality and wildlife habitat.
- ✓ Relative to the Conservation Reserve Enhancement Program (CREP), more consistent guidelines and coordination of landowner payments between the Farm Services Agency and the MDA would ease implementation for landowners, thereby prompting greater program participation.
- ✓ Both the MACS program and EQIP provide cost-share nutrient management planning. EQIP could be made more attractive to farmers by providing the cost-share money up front, as opposed to spreading payments over three years. On the other hand, the MACS program requires all of a farmer's acreage to be covered under a nutrient management plan, whereas it was felt that allowing for incremental coverage of acreage would assist farmers.

- ✓ In general, both governmental and non-governmental program managers felt that cost share programs needed more money in them to truly create an incentive for landowners to participate. The CREP and Cover Crops Program were both given as examples.
- ✓ Tracking best management practice implementation was a large concern of program managers, especially the need for consistent methods and shared resources between the federal and state agencies. Managers also cited Geographic Information System (GIS) expertise and support as necessary to help manage their information and assist them in carrying out their duties.
- ✓ The Critical Area Program was thought to second-guess local government decision-making. The development review process was considered cumbersome at times and the program's geographic scope (only covering 1000 feet from tidal waters) was not resulting in a positive cost-benefit ratio.
- ✓ From a non-governmental organization perspective, concern was raised that it was extremely difficult to find volunteers to help with conservation or restoration projects. A lack of citizen groups in general in the study area was often cited as a barrier to volunteer program implementation.
- ✓ Lack of "local" surface and groundwater monitoring data was given as a hindrance to program implementation. For surface waters, program managers felt there was sufficient information available for the tidal portions of the study area, but that lack of non-tidal or freshwater monitoring information hampered their ability to focus program implementation efforts. Managers thought that a balance needed to be struck between the collection of freshwater or non-tidal water quality data and tidal water quality information, especially since they were not clear how the tidal water quality information would assist them in administering their programs. Some also thought there was existing information that would help them, but they didn't have knowledge of where the information was or how to get it.
- ✓ Several program managers (both governmental and non-governmental) felt that their programs would benefit from State and federal agencies' making their information or data more readily available. They cited lack of staff and money as reasons for wanting to utilize information that would allow them to get the "biggest bang for the buck" from their program implementation. They felt that the State and federal governments could do a much better job of both letting them know what information was available and getting it to them.

The Indicators

The environmental indicators which follow were chosen by the Steering Committee to paint a picture of water quality and related issues found in the Lower Eastern Shore Tributary Basin. Most of them were mapped on a statewide basis as part of the Unified Watershed Assessment carried out as an earlier phase of the Clean Water Action Plan.

- Nitrogen Loadings from the watershed to the Chesapeake Bay (Modeled)
- Phosphorus Loadings from the watershed to the Chesapeake Bay (Modeled)
- Soil Erodibility
- Animal Units
- Septic Systems



Point and Nonpoint Source Nitrogen Loadings

(Modeled - 1996)

The Indicator

Nitrogen is one of the two nutrients deemed the greatest pollutants of the Chesapeake Bay because of their contribution to eutrophication. Total nitrogen *delivered from each watershed to Chesapeake Bay* was derived from the Chesapeake Bay Program's Phase IV Watershed Model and the Maryland Department of Natural Resources' Integrated Watershed Analysis and Management System (IWAMS). Nonpoint source loads—annual loads based on average meteorological conditions—include contributions from conventional till agriculture, conservation till agriculture, hayland, pasture, forest, urban areas, septic systems, manure, and air deposition to open water. Point source loads are calculated by multiplying together actual discharge data for each facility, provided by the Maryland Department of Environment, and a delivery factor.

Nonpoint loads are calculated by multiplying together the land use loading rate, the number of acres of the land use type, a delivery factor, and a best management practice (BMP) factor. The estimated loading rates for each land use or source were derived using computer models, calibrated with Bay region monitoring data and studies reported in the scientific literature. The land use information is based on 1996 land use/land cover estimates. The delivery factor is used to simulate the transport of the load from the watershed, down the river, to the Chesapeake Bay; it is used to account for the portion of the total nitrogen leaving the land or waste treatment facility that undergoes chemical or biological change as it travels downstream and, therefore, does not reach the Bay. The BMP factor is used to account for management practices that prevent the total nitrogen applied to the land from reaching streams.

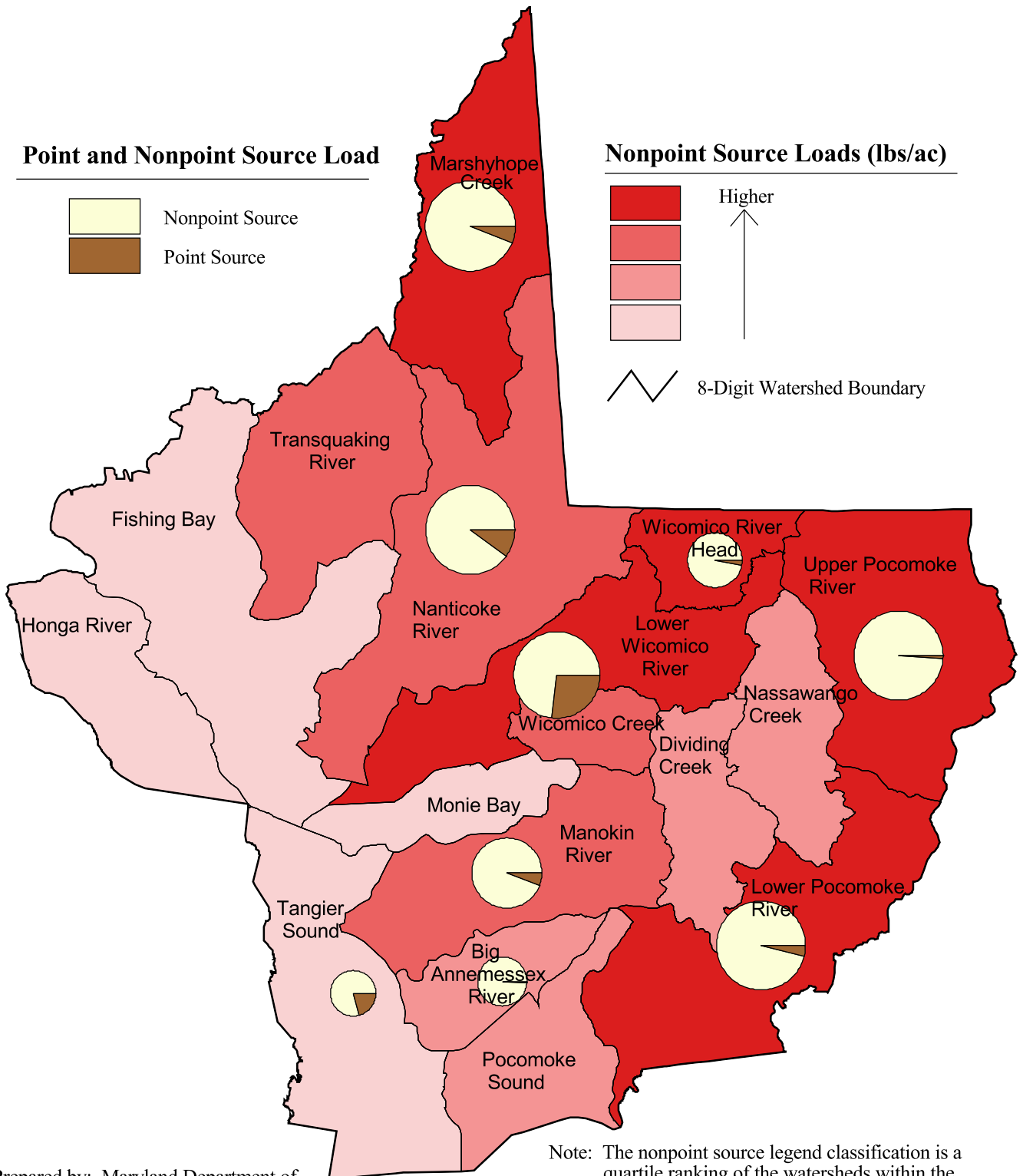
Interpretation

The Lower Eastern Shore Tributary Basin is a significant contributor to nitrogen loadings in the Bay, containing five of the 34 watersheds with the highest nonpoint source loads of nitrogen, according to the Chesapeake Bay watershed model. Only one large urban area is found in the Lower Eastern Shore watersheds with the highest loads—Salisbury is located in the Lower Wicomico River watershed. Much of the nonpoint source nitrogen load in the five watersheds, thus, comes from the dominance of agricultural land use. The very low values found in the watersheds immediately adjacent to the Chesapeake Bay reflect the prevalence of wetlands in these areas.

Indicator Use

The watersheds with the highest values for this indicator offer the greatest potential for interventions addressing sources of nitrogen: agricultural programs might target efforts to plan and implement “best management practices” that demonstrate effectiveness in preventing nitrogen from running off or from getting into shallow ground water; local planners might look for opportunities in these watersheds to install or retrofit stormwater management facilities or demonstrate alternative septic systems.

Point & Nonpoint Source Nitrogen Loadings (Modeled)



Prepared by: Maryland Department of
Natural Resources

Note: The nonpoint source legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin. Pie charts compare point and nonpoint source loads per watershed. Those watersheds without a pie chart have no permitted point source discharges.

Point and Nonpoint Source Phosphorus Loadings

(Modeled - 1996)

The Indicator

Phosphorus is the second important nutrient contributing to Chesapeake Bay eutrophication. As with nitrogen, phosphorus loads delivered from each watershed to Chesapeake Bay were derived from the Chesapeake Bay Program's Phase IV Watershed Model and the Maryland Department of Natural Resources' Integrated Watershed Analysis and Management System (IWAMS). Nonpoint source loads are annual loads based on average meteorological conditions. Point source loads are provided by the Maryland Department of the Environment for all active industrial, municipal, and federal facilities discharging to surface waters and are based on actual discharge rates and concentrations. Phosphorus loads were calculated in the same way nitrogen loads were, including use of best management practices (BMP) and delivery factors. The land use information is based on 1996 land use/land cover estimates.

Interpretation

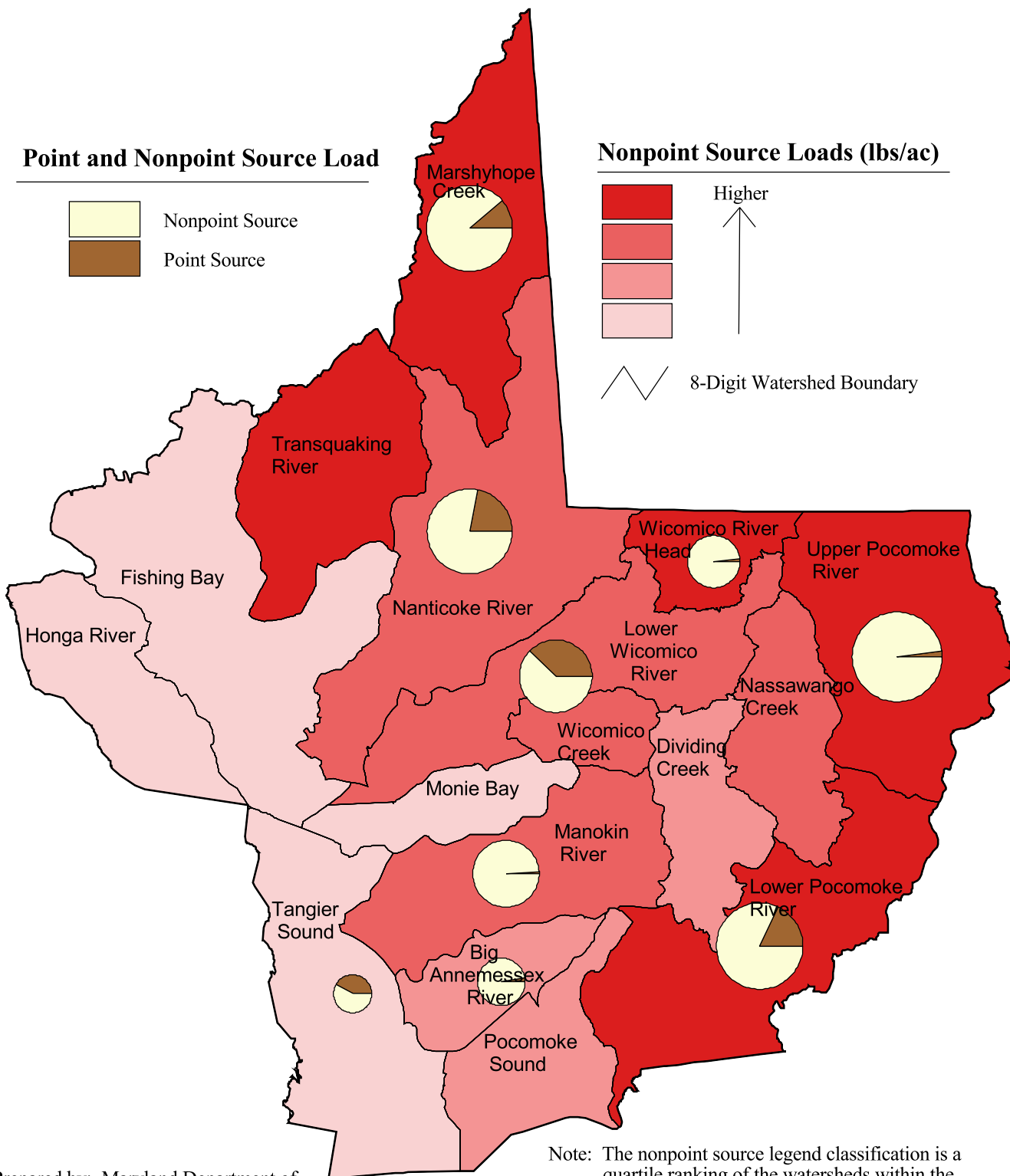
In 1996, in the Lower Eastern Shore Tributary Basin, 90% of the total phosphorus loads were generated by nonpoint sources and 10% by point sources, according to the Chesapeake Bay watershed model. The Lower Eastern Shore Tributary Basin contains five watersheds in the top quartile for nonpoint source loads of phosphorus statewide. In fact, an estimated 18% of Maryland's nonpoint source loads are generated in the Lower Eastern Shore Basin. In contrast, only 6% of the State's point source loads are generated here.

A number of other Maryland watersheds with high phosphorus loadings contain heavily urbanized areas in the Baltimore-Washington corridor, where point sources such as municipal wastewater treatment plants can contribute up to a quarter of the total phosphorus loads. In contrast, only one substantial urban area is found in the Lower Eastern Shore watersheds with the highest loads—Salisbury is located in the Lower Wicomico River—and only about 13% of the total load is contributed by urban sources. Overall in the Lower Eastern Shore Tributary Basin, nearly 83% of the phosphorus load is contributed by agricultural sources, although only about a third of the land is used for agriculture.

Indicator Use

Interventions for improving water quality in the Lower Eastern Shore Tributary Basin clearly must address primarily nonpoint sources and need to focus on agriculture. With recognition that phosphorus does not stay bound to sediments when soils become as saturated with phosphorus as appears to be the case in the Lower Eastern Shore, changes in the design and application of BMPs may be necessary to focus on removing phosphorus from shallow ground water as augmentation to the traditional approach of reducing sedimentation from runoff. As with nitrogen, attention can be focused first on the watersheds depicted with the highest loadings.

Point & Nonpoint Source Phosphorus Loadings (Modeled)



Prepared by: Maryland Department of
Natural Resources

Note: The nonpoint source legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin. Pie charts compare point and nonpoint source loads per watershed. Those watersheds without a pie chart have no permitted point source discharges.

Animal Units

The Indicator

Animal units representing 1000 pounds of a particular animal type were derived from animal numbers reported in the 1997 USDA-NASS Census of Agriculture. Animals represented include: beef cows, dairy cows, swine, poultry layers less than 3 pounds, poultry layers greater than 3 pounds, and turkeys. Animal units are used to estimate the amount of manure voided in a particular area. The county-based numbers were distributed to Chesapeake Bay Program Phase 4.2 Watershed Model “county-segments” (which are not comparable to the watersheds used in other indicators in this report) using the ratio of herbaceous acres in each of the county-segments to total county herbaceous acres.

Manure provides nutrients that may be utilized by crops. The manure is also a source of nutrient runoff to nearby streams and infiltration to ground water. Manure may be voided in either confined or unconfined areas. Manure voided in unconfined areas is assumed, in the Chesapeake Bay Program’s Phase 4.2 Watershed Model, to occur in pastureland. Manure voided in confined areas may be stored for future application on land when crops can utilize the nutrients, and when the soil and weather conditions are appropriate. During the process of collecting and storing the manure, nutrients may be lost from the facility in the form of runoff. Assumptions are made in the model for each type of animal to determine how much manure is voided in confined areas and how much is susceptible to runoff from the facility. Best management practices (BMPs) are employed on a portion of the confined manure to reduce runoff from the facility.

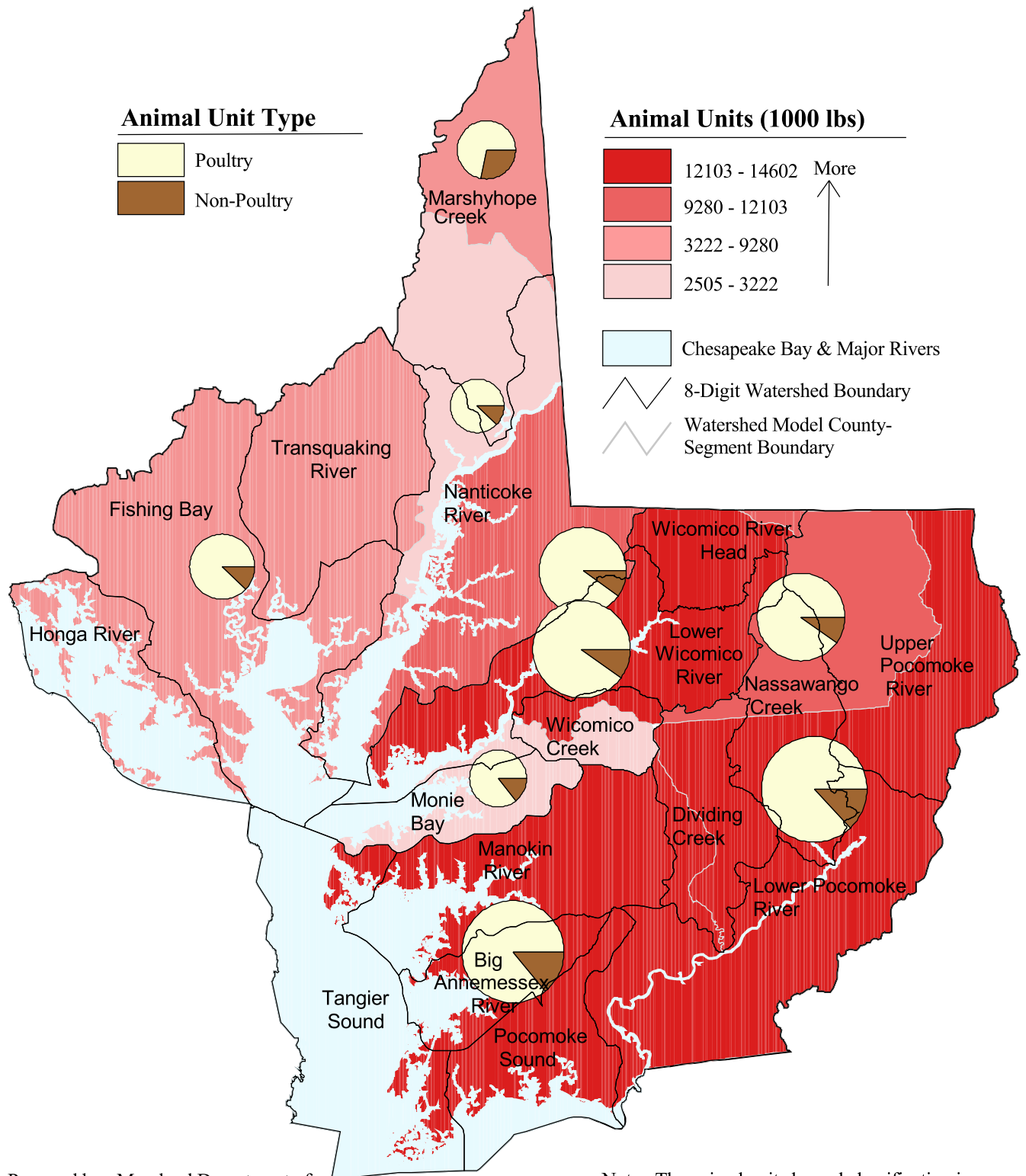
Interpretation

The Lower Eastern Shore Tributary Basin contains 18% of the state’s total animal units. To get a handle on the potential impacts of animal manure, the composition of the animal unit is important, since each animal unit category produces different amounts of manure. Additionally, different amounts of nutrients per animal unit are produced by each type of animal. The nutrient content of poultry manure is higher than the nutrient content of manure produced by beef cows, dairy cows or swine. For example, while one animal unit of poultry broilers produces about 90% of the manure produced by one animal unit of beef cows, the poultry manure contains more than three times the amount of nitrogen and more than 5 times the amount of phosphorus produced by the beef cows. This is important in the Lower Eastern Shore, since poultry represents about 83 percent of the animal units—about 60% of Maryland’s total poultry population. The Lower Eastern Shore has 3% of the state’s non-poultry animal units.

Indicator Use

The large amount of poultry raised in the Lower Eastern Shore, coupled with the high nutrient content of poultry manure, points to the contribution of manure to the high nonpoint source loads of nutrients reported in other indicators and suggests a focus on animal wastes in improving management practices for future implementation.

Animal Units



Prepared by: Maryland Department of Natural Resources

Note: The animal units legend classification is a quartile ranking of the County-Segment areas within the Lower Eastern Shore Tributary Basin. Pie charts compare animal units of poultry and non-poultry.

Septic Systems

The Indicator

The number of people using private septic systems to manage their households' wastewater is a stressor indicator—septic systems provide multiple opportunities to introduce pollutants, including nitrogen and phosphorus, into both ground water and surface water. Improperly installed or maintained septic systems also may present public health impacts and result in calls for costly relief through the provision of public sewerage.

This indicator is calculated as the number of housing units within a watershed that rely on septic systems to handle human wastes. The numbers were derived from the 1990 U.S. Census of Population, allocated to the Maryland Department of Environment's designated second level, or eight-digit, watersheds.

Interpretation

Numbers of septic systems in the watersheds of the Lower Eastern Shore Tributary Basin reflect the distribution of the basin's population and the small number of municipalities with public sewerage systems. Even in watersheds having incorporated towns with sewage treatment plants, such as Salisbury in the Lower Wicomico River watershed, there are large numbers of septic systems, reflecting the dispersal of population outside the reach of the public systems.

Septic systems also contribute to the predominance of nonpoint sources of nutrients depicted in other indicators. Since use of septic systems is usually associated with low residential density, providing public sewerage to relieve problems of failing septic systems, or septic system contributions to ground and surface water degradation, is very expensive if not outright infeasible. At the same time, reliance on septic systems helps to perpetuate low-density development, because of regulations for installation of new systems that stipulate relatively large lot sizes in order to protect public health.

Indicator Use

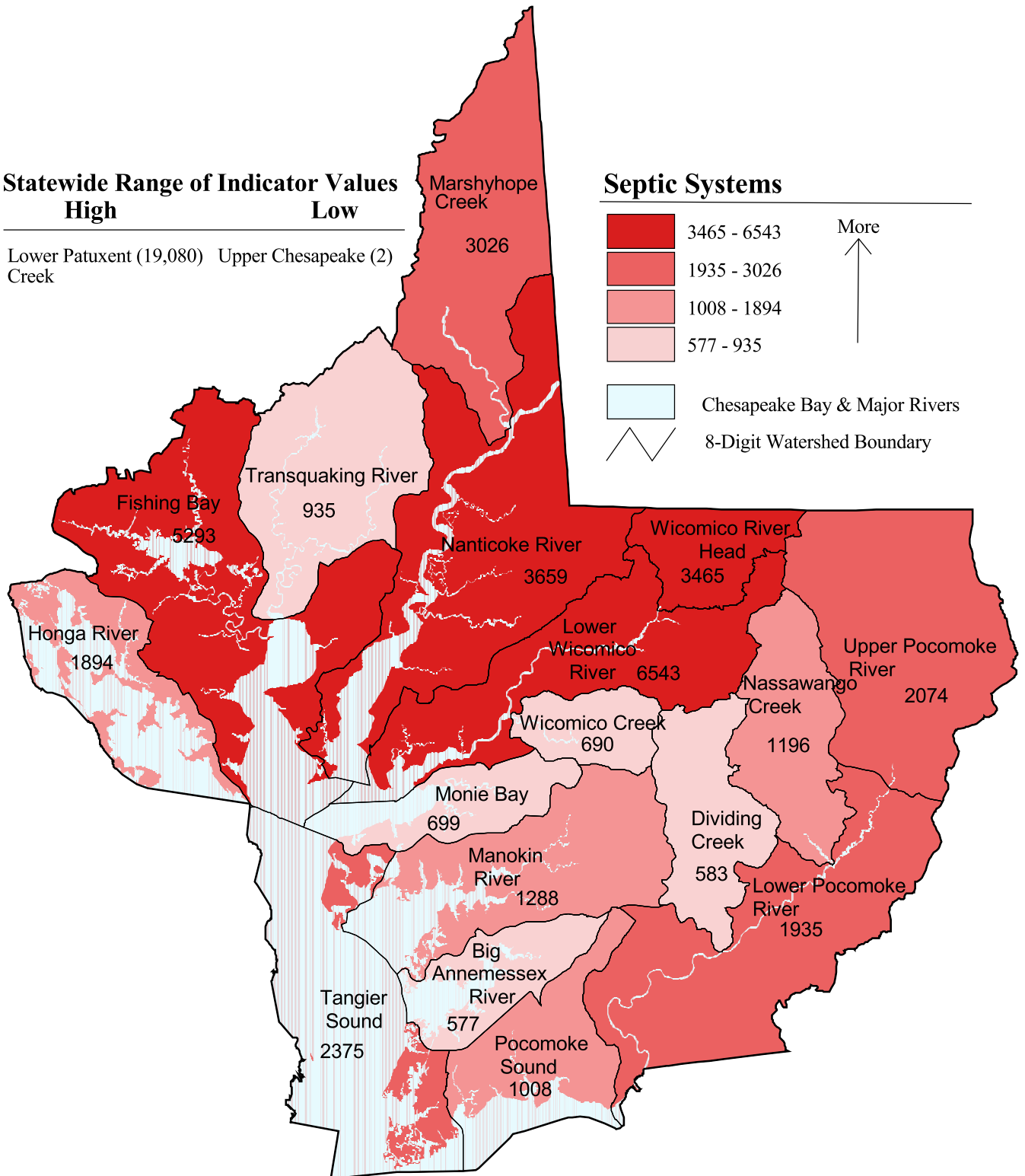
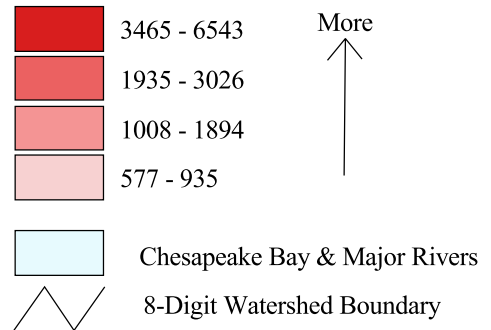
The Governor's Smart Growth initiative envisions new development occurring contiguous to existing towns and cities where public services, including water and sewer, might already be available or could be provided more readily than to more scattered development. Where there are significant numbers of septic systems that cannot feasibly be connected to existing or planned sewage treatment systems, local authorities might consider establishing mechanisms to improve management of the septic systems, including improved homeowner education or establishing and overseeing pump-out schedules. Continued reliance on septic systems, and the locations of areas with septic systems, also have implications for the operation of sewage treatment plants which receive or might receive the septage from septic tank maintenance operations.

Septic Systems

Statewide Range of Indicator Values

High Low
Lower Patuxent (19,080) Upper Chesapeake (2) Creek

Septic Systems



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Soil Erodibility

The Indicator

Sedimentation from eroding soils contributes to the lack of water clarity that plays a major role in the decline of Bay grasses. Other pollutants, including the nutrient phosphorus, may be bound up in the sediments and thus conveyed to surface waters, also.

Erodibility, represented in this indicator by what is known as the “K-factor,” is a measure of the susceptibility to erosion of bare surface soil. K values for Maryland soils are estimated in Table 1 in the Natural Soils Groups of Maryland technical report (Maryland Department of State Planning, 1973). To develop an 8-digit watershed K value, all the K values found in each watershed were multiplied by the percentage of the watershed each soil covered, and their products were summed to produce a generalized watershed K value. Soils that were classified as “water” were removed from the databases so as not to bias the watershed K value. Soils that were not identified with a K value were assigned a value of zero, except that Natural Soil Groups listed as “G” were assigned a value of 0.17 and Natural Soil Groups listed as “H” were assigned a value of 0.30. This may induce a bias in the watershed K value. This entire procedure assumes that small scale variability of hydraulic conductivity for natural soils groups can be aggregated up to an average for an 8-digit watershed.

The K factor normally varies from approximately zero to about 0.6. A K value of 0.17 denotes a very low erosion potential; a value of 0.32 shows a moderate erosion potential; a value of 0.37 suggests a high and a value of 0.43 a very high erosion potential.

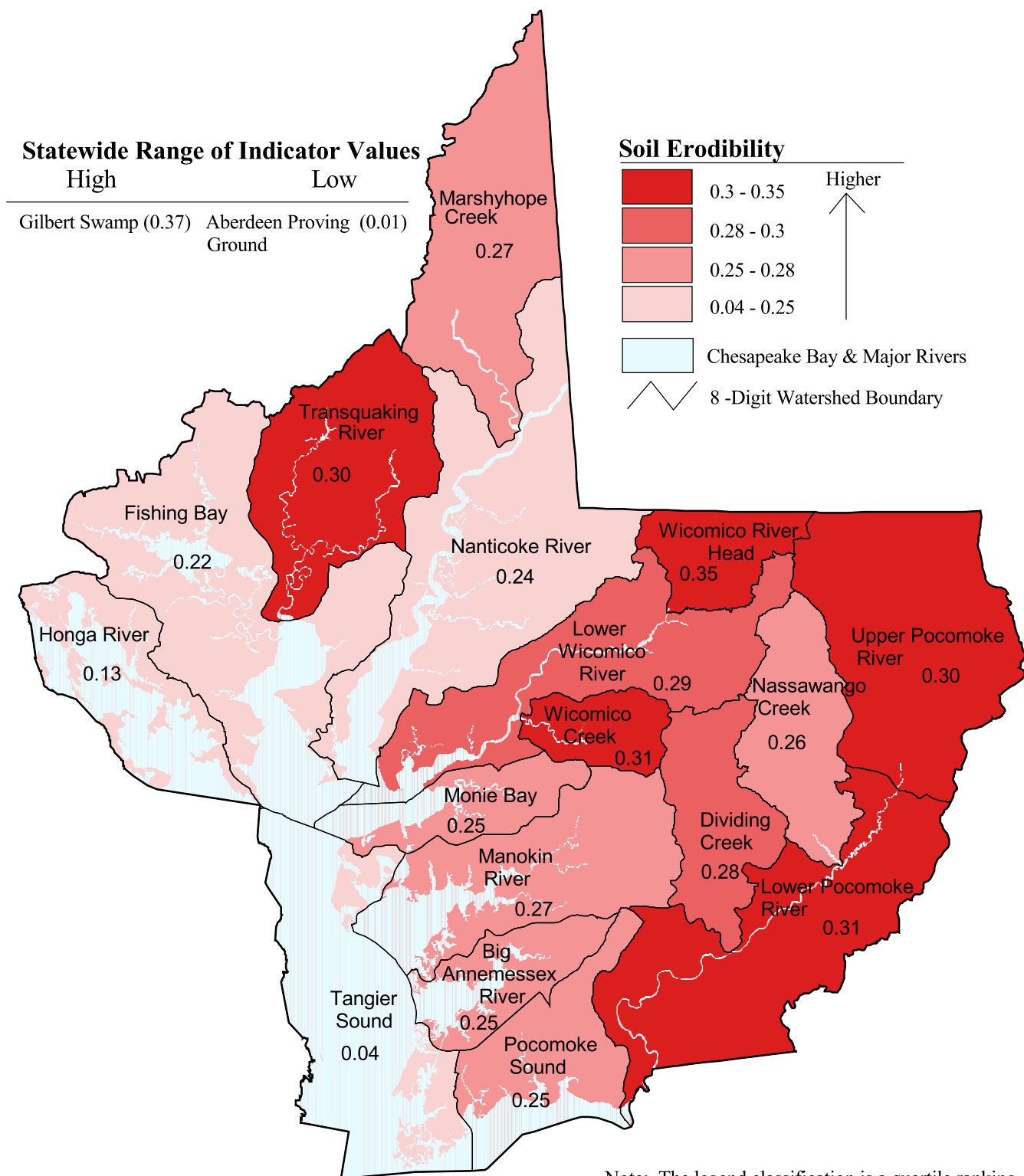
Interpretation

Although no Lower Eastern Shore watersheds are classified as having a very high or high erosion potential, several have a moderate erosion potential—the Lower Eastern Shore Tributary Basin contains seven of the 71 watersheds in the state that were ranked in the top two quartiles statewide, and Wicomico River Head is tied as the third highest ranked watershed in the state. Caution is needed in interpreting the indicator, however, because smaller areas with high or very high erosion potential have been masked by aggregating the data to the 8-digit watershed level.

Indicator Use

The watersheds with the highest values for this indicator offer the greatest potential for interventions addressing soil conservation such as the Conservation Reserve Enhancement Program and riparian buffer forestation. Best management practices concerned with keeping topsoil in place would be ideal for implementation in these watersheds. This indicator would be useful when combined with additional information about cropland, slope steepness, and distance to streams, as this would indicate areas where one best management practice—retirement of highly erodible land—would be most useful. High values for this indicator also raise warning flags about other, more urban activities near streams, such as road construction or utility placements.

Soil Erodibility



Prepared by: Maryland Department of
Natural Resources - 1999

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Summary of Water Quality Indicators

Table 2 summarizes the values used to develop the indicator maps for Septic Systems and Soil Erodibility and the rankings of the watersheds for modeled loads of nitrogen and phosphorus delivered to the Chesapeake Bay. Because the Animal Units indicator was not mapped on the same watershed basis as the other indicators, the data are not included here. The Upper Pocomoke River, Lower Pocomoke River, Wicomico River Head and Marshyhope Creek watersheds were all rated in the lowest 25% for more than half the available indicators.

Table 2
Watersheds and Water Quality Indicators

Watershed Name	NPS Nitrogen Load Ranking*	NPS Phosphorus Load Ranking*	Soil Erodibility Index	Septic Systems	Number of Times in Lowest-rated 25%
Wicomico River Head	3	3	0.35	3465	4
Lower Pocomoke River	4	3	0.31	1935	3
Upper Pocomoke River	2	2	0.30	2074	3
Marshyhope Creek	1	1	0.27	3026	3
Lower Wicomico River	5	6	0.29	6543	2
Transquaking River	6	5	0.30	935	2
Fishing Bay	15	15	0.22	5293	1
Wicomico Creek	8	7	0.31	690	1
Nanticoke River	7	8	0.24	3659	1
Monie Bay	14	14	0.25	699	0
Big Annemessex River	11	11	0.25	577	0
Manokin River	9	9	0.27	1288	0
Nassawango Creek	10	9	0.26	1196	0
Dividing Creek	13	13	0.28	583	0
Tangier Sound	17	17	0.04	2375	0
Honga River	16	16	0.13	1894	0
Pocomoke Sound	12	12	0.25	1008	0

* Rankings are from 1 (highest loads–worst condition) to 17 (lowest loads–best condition).

Disruption to Hydrologic Processes

Hydrologic processes are probably the ecological processes most visibly impacted by human activity. Floodplains, with their associated riparian communities, have been filled or built on; channels have been straightened or armored; thousands of acres of the watershed have been paved or covered with roofs, interfering with the percolation of rain and snow-melt into ground water; wetlands have been filled or drained; and water has been diverted from one drainage area to another. And while research and assessment of water pollution problems have grown along with concern for the Chesapeake Bay, understanding the impact of hydrologic modification, and its interaction with other factors affecting both the Bay and terrestrial systems, has not grown apace and is not so often reflected in decision making.

Stressors and Sources

Water for human consumption and industrial processes, for agriculture and for supporting natural communities, for transportation and for recreational use—it is not always available where and when human communities want it. A serious consideration of the relationship of available water and the human uses desired of it has not historically preceded many major decisions about how to settle the land and how to make a living from it.

Because of the importance of water for transportation and for industrial development, proximity to navigable or moving water was a major consideration in historic decisions to locate towns and cities, in Maryland as elsewhere. The potential danger to the human uses from flooding, much less the changes to stream function caused by encroachment into the floodplain, were far from uppermost in anyone's mind. The need to expand agriculture to feed growing populations led to many of the efforts to drain wetlands that have more recently been seen as deleterious to ecosystems where drainage occurs and, ultimately, to the health and welfare of the populations dependent on those ecosystems.

As watersheds have been developed into human communities of houses, commercial areas, institutions and industries, all linked by roads and served by parking areas, water falling on the earth has been forced into human-designed paths, emptying into streams more rapidly and in greater amounts, changing the channels and courses of the streams. When less water is left to percolate more slowly into the ground, the base (dry weather) flow of water in streams declines, affecting the living resources in these streams.

Lower Eastern Shore Issues

Members of the Steering Committee for the Lower Eastern Shore Conservation and Restoration Action Strategy, in brainstorming issues faced by their tributary basin, identified only two under the theme of hydrologic modification. Concern about ground water was expressed primarily in terms of water quality, although there is at least localized interest in the issue of quantity.

- Floodplains and their relationship to development potential; large swaths of some counties, including lands around the existing communities that should, under Smart Growth, be targets for additional development, are in coastal flood areas. (This issue was considered less important by the Steering Committee.)
- Wetland restoration efforts and their impact on local land use planning.

Another issue in the Lower Eastern Shore, recognized by the Tributary Team and state officials, also plays a major role, perhaps the most important role, in modifying the hydrology to advance human purposes:

- Drainage ditches constructed to provide early growing season access to farm fields and to allow residential and other development.

Relying on an extensive network of ditches has had major, unintended side effects on water quality and both terrestrial and aquatic systems. At the same time, ditches are seen as necessary to support the agricultural economy and, in many cases, to allow development. Perhaps the primary hydrology issue in the Lower Eastern Shore may thus be a perceived conflict in the goals being pursued.



Management Programs

State programs dealing with hydrologic modification include both regulatory and incentive approaches.

Regulatory approaches deal with limiting or preventing encroachment on natural floodplains and protecting non-tidal wetlands. Curiously, the incentive programs promote or support both protection of non-tidal wetlands and actions which interfere with the hydrologic processes necessary to sustain them.

- ***Agricultural Water Management Program*** (MDA) helps public drainage associations maintain agricultural drainage through cost-share maintenance and interagency review of plans for construction, reconstruction, operation, and maintenance.

- ***Floodplain Management Program*** (MDE) provides for State oversight of local floodplain ordinances limiting uses in delineated floodplains.
- ***Wetlands Reserve Program*** (NRCS) allows farmers to sell permanent or 30 year easements to the Department of Agriculture. The easement must provide for a wetland easement conservation plan that restores the wetland and restricts public access. The program provides for cost-share to restore altered wetlands to natural condition, even if the land is not placed in an easement.
- ***Non-tidal Wetlands and Waterways*** (MDE) oversees the permit process for construction projects affecting nontidal wetlands, such as swamps, bogs, marshes, bottomlands, and woodlands, their buffer zones, and nontidal waterways, including the 100-year flood plain.
- ***The Critical Area Program*** limits the amount of impervious surface that can be installed in the 100-foot buffer adjacent to tidal waters and wetlands.
- ***Non-tidal Wetlands Program*** (MDE) can provide up to 100% funding for non-tidal wetlands enhancement, restoration and creation. An easement or landowner agreement would be required for funds spent on private land.
- ***Partners for Wildlife Program*** (U.S. Fish and Wildlife Service) assists landowners informally or by cooperative agreement to restore degraded or converted wetlands and implement a management plan.

Program Issues and Observations

- ✓ The Floodplain Management Program is no longer funded to make grants to local governments for actions to alleviate flood damage, including the removal of flood-prone structures from floodplains.
- ✓ Wetland restoration on productive agricultural lands will be politically difficult, although Somerset County, for one, has had a successful restoration effort under way with farmers with excessively wet or salt-damaged fields.
- ✓ Data for mapping ditches, and for distinguishing ditches from other streams, are presently lacking. In fact, the digital stream data available are very poor. This makes it impossible to support an indicator which might directly track what is arguably the most significant issue affecting both the hydrology and water quality on the Lower Eastern Shore. Resolving data problems of this sort is ineligible for Clean Water Action Plan funding and is the sort of unglamorous activity that tends to be ignored in other funding programs.
- ✓ While some program managers felt that funding for maintenance of Public Drainage Association (PDA) ditches should be re-instated by the State, others thought that public funds should only be expended for maintenance if the maintenance activity was not causing other environmental damage such as water quality degradation or habitat loss. NOTE: a public drainage Task Force has begun to address such issues.

- ✓ There was some question about the validity of spending public funds on restoration activities in watersheds where the streams had been heavily ditched.
- ✓ Data on the quantity and quality of ground and surface waters, and the effects of human consumption and use, are lacking. For rapidly developing areas, local planners felt that this was critical information they don't have.

The Indicators

The indicators available to deal with hydrologic modification all deal with the impacts of human development. Two reflect conscious decisions regarding water use, while two are the repercussions of development actions taken without particular regard to their impact on hydrology or ecosystem function. At this time there are no data to support indicators that might more accurately or directly track the issues that have been identified for the Lower Eastern Shore Tributary Basin.

- Historic wetland loss
- Percent of impervious surface
- Permitted surface water withdrawals
- Permitted ground water withdrawals



Historic Wetland Loss

The Indicator

Wetlands can be lost by lowering the local water table through ditching, by excessive pumping of the surface water table, or by blocking the flow of recharge water from its source. Soils which must be drained at least part of the year in order to support agriculture are considered historic wetlands now converted to other uses.

The indicator maps non-wetland hydric soils—soils which are or at one time were saturated with water much of the year. Saturated soils frequently show accumulations of organic matter in excess of similar unsaturated soils because the anaerobic bacteria are less efficient at breaking down organic material than are aerobic bacteria. The presence of the excess organic material and the absence of free oxygen causes these soils to become highly acidic, which in turn changes their color, permitting detection of hydric soils after they cease to be saturated with water. The chemical environment of saturated soils favors the reduction of nitrates to gaseous nitrogen, thus reducing the nitrate loadings of the water which passes through the saturated zone of the wetland soils. The longer a soil remains unsaturated, the more the organic material is oxidized, the lower its fertility becomes and the less identifiable the hydric soil characteristics become.

To calculate the indicator, all the soils classified as hydric on maps prepared for the Maryland Office of Planning were combined with National Wetland Inventory (NWI) maps. Hydric soils coinciding with areas identified by NWI as wetlands, or which are permanently flooded by standing water—ponds, rivers or the bottom of bays or estuaries—were subtracted; the resulting map comprises non-wetland hydric soils.

Interpretation

A high watershed acreage of non-wetland hydric soils points to a history of hydrologic modifications in that watershed, including agricultural ditching or tiling for improving soil tillage. These practices have been widespread and of long standing in the Lower Eastern Shore Tributary Basin. Only the Honga River, Monie Bay and Big Annemessex River watersheds did not score in the highest quartile statewide for this indicator when the Unified Watershed Assessment was prepared. As the map shows, the Upper Pocomoke River watershed includes the largest acreage of converted wetlands in the State.

Indicator Use

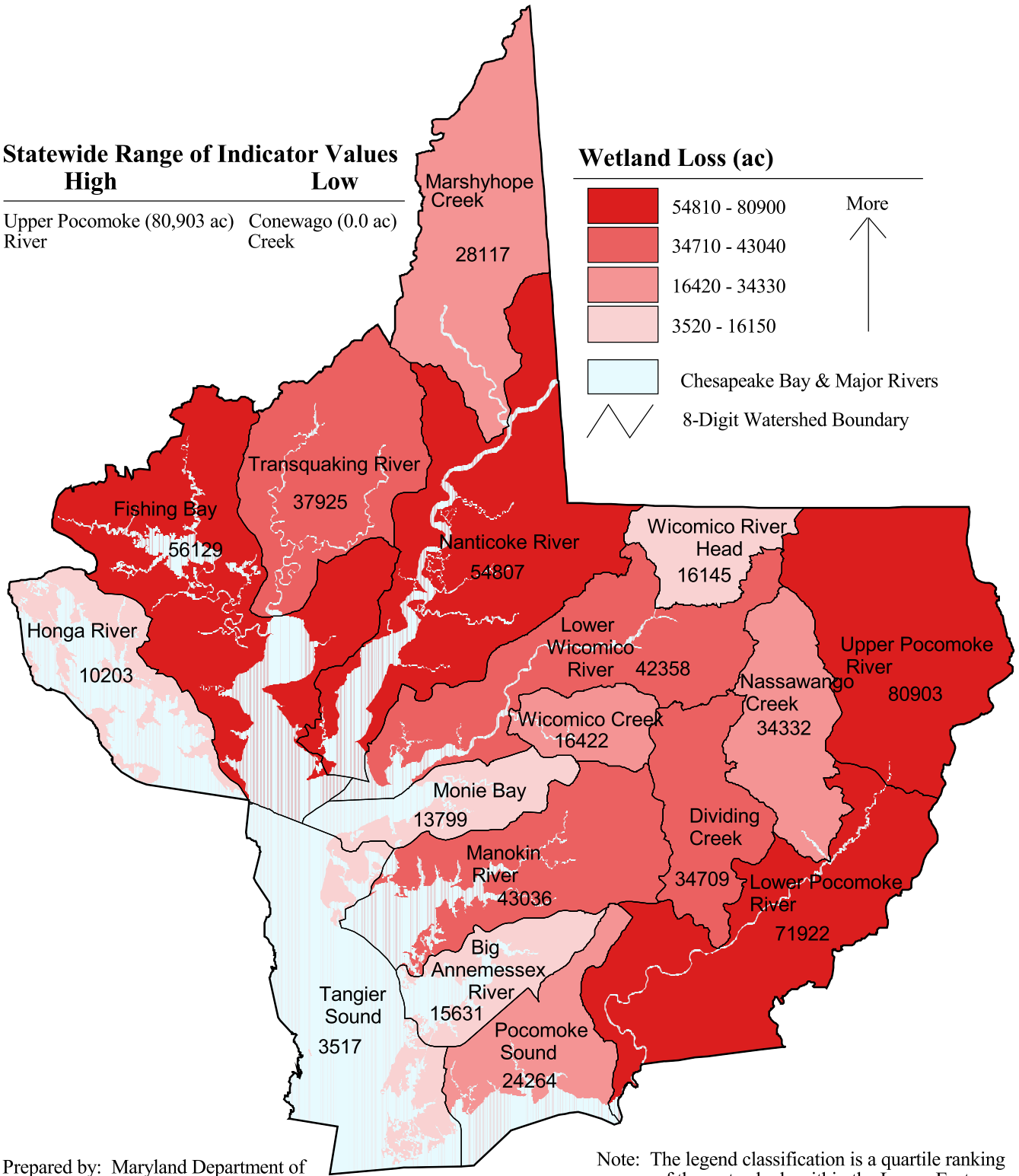
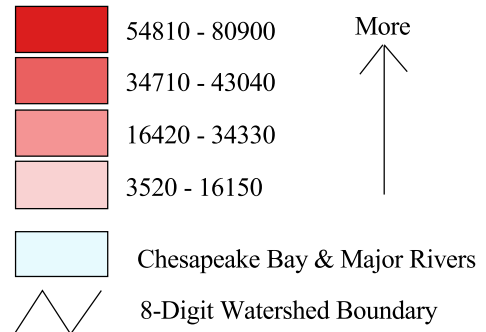
A high acreage of non-wetland hydric soils helps to identify potential for the restoration of wetlands for flood amelioration, wildlife habitat and water quality improvement functions. It will be easier and less expensive to restore the hydrology to a place where it formerly existed than to alter a site to provide surface saturation where it has not previously existed.

Historic Wetland Loss

Statewide Range of Indicator Values

High	Low
Upper Pocomoke (80,903 ac) River	Conewago (0.0 ac) Creek

Wetland Loss (ac)



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Percent Impervious Surface

The Indicator

Impervious surface encompasses land areas covered by roofs, roads, parking lots and other materials which keep rainfall and snow from penetrating the ground. Watersheds with a high percent of impervious surface area are susceptible to increased stormwater runoff and decreased water quality in nearby surface waters. Impervious surfaces channel water into smaller areas, which in turn helps to increase flow velocities, sometimes resulting in localized flooding and, frequently, in accelerated erosion of streambanks.

To estimate impervious surface on a watershed basis, Maryland Office of Planning (OP) 1994 land use data were allocated to Maryland Department of Environment-designated eight-digit watersheds. Impervious surface was calculated from a combination of “urban” land classifications (low density residential; medium density residential; high density residential; commercial; industrial; institutional, extractive and other urban; large lot residential; and other) and lands classified as “barren.” Each land cover class was assigned a “percent impervious” factor based on the U.S. Soil Conservation Service TR-55 Manual; the applicable percentage was multiplied by the acres in each class to derive total impervious area. The percent impervious surface indicator was developed by normalizing the impervious surface acres by the total land acres in the watershed.

Interpretation

The Maryland Biological Stream Survey has related the percent impervious surface in a watershed to the health of aquatic resources. For areas with less than 4% impervious cover, streams generally rate “Fair” to “Good” for both fish and instream invertebrates; beyond about 12% impervious surface, streams generally rate as poor to fair for both. Because much of the land in the Lower Eastern Shore Tributary Basin is classified as agricultural, forested, or wetland, the percentages of impervious surface are relatively small compared to the rest of the state. The Dividing Creek watershed, in fact, has the lowest percentage of impervious surface of all the watersheds in the state. There are no Lower Eastern Shore watersheds whose percent impervious surface placed them in the top quartile classification for the state, rating them as in need of restoration according to the Unified Watershed Assessment.

Indicator Use

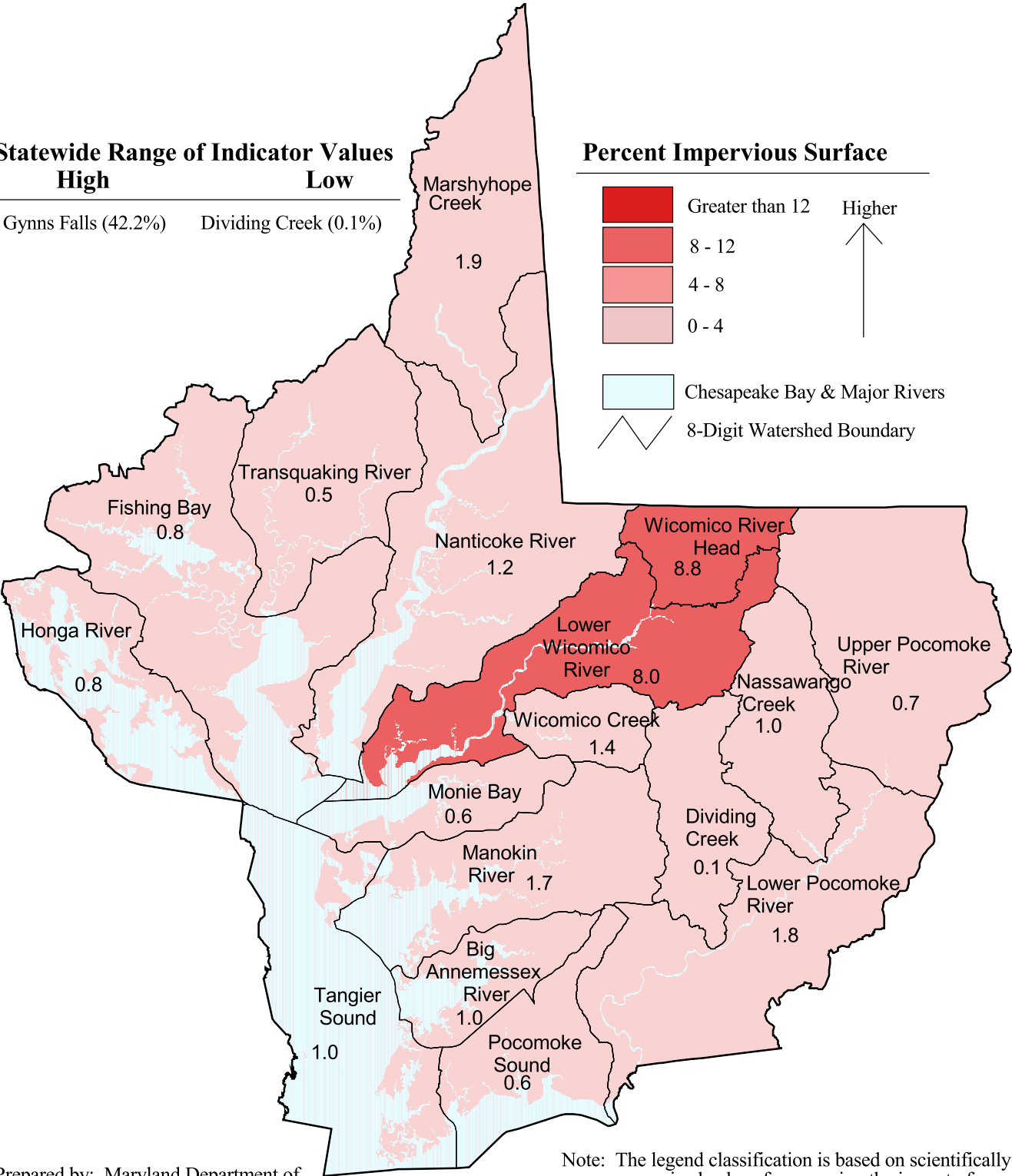
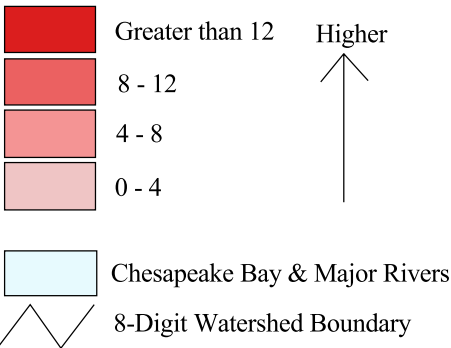
The watersheds with the highest values for this indicator offer the greatest potential for implementation of best management practices whose objective is to filter runoff and moderate runoff peak velocities. Local planners, for example, might look in these areas for opportunities to install or retrofit stormwater management facilities or to take steps to redesign roads and parking lots so they become less effective in channeling rainfall.

Percent Impervious Surface

Statewide Range of Indicator Values

High	Low
Gynns Falls (42.2%)	Dividing Creek (0.1%)

Percent Impervious Surface



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is based on scientifically recognized values for assessing the impact of impervious surfaces on stream habitat and water quality

December 1999

Surface Water Withdrawals

The Indicator

Supplying water for agricultural irrigation and for a variety of urban purposes—residents, commercial areas, power production and other industry—is one of the most visible functions of the water resources of the State. Water for these purposes may be withdrawn from surface sources like rivers or reservoirs, as depicted in this indicator, or from ground water. Human use of surface water has to be balanced, in the permitting system, with the needs of fish and benthic communities.

Information for this indicator was derived from a file developed by the Water Rights Division of the Maryland Department of Environment, which has the responsibility for regulating water use through an appropriation permit system. The mapped information incorporates permits issued through 1998.

Interpretation

Although the great majority of the water withdrawn in Maryland, statewide, is derived from surface water sources, the situation is reversed in the Lower Eastern Shore Tributary Basin, where less than 30% is derived from these sources. Perhaps paradoxically, given the amount of wetland drainage and ditching that has occurred in this basin, the great majority of this water is used for agriculture. This amounts to a major modification of the natural hydrological system, with water being diverted from one place to another in accordance with the desires, and the timing of those desires, of the human members of the ecosystem.

Indicator Use

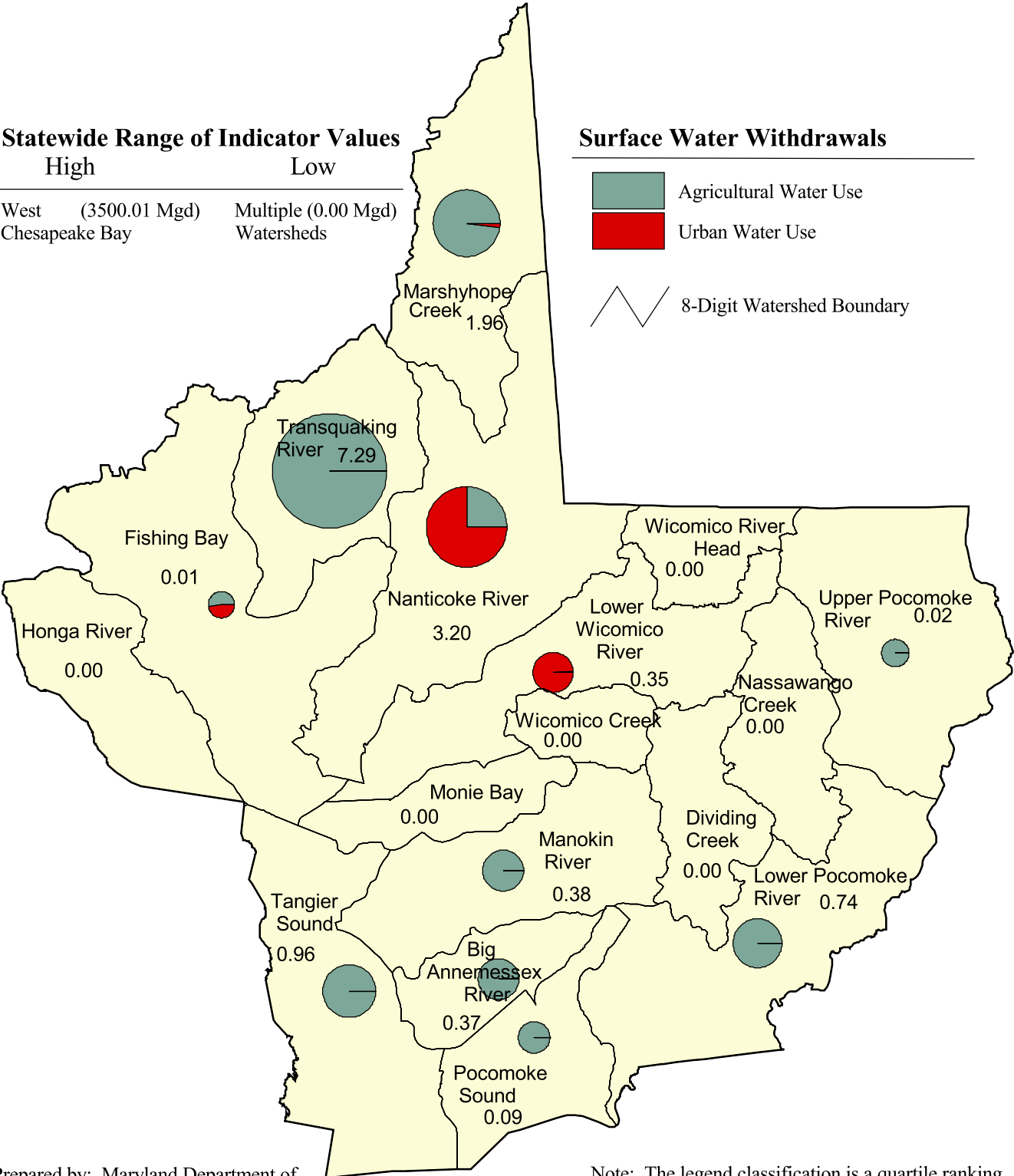
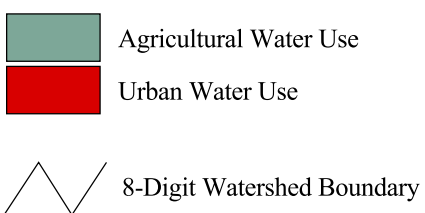
While there has been a long-standing perception that the State of Maryland had an adequate supply of water for all its citizens and for all uses, a drought emergency was called during the summer of 1999. The 1999 drought has highlighted the interconnectedness of water quantity and water quality, as salinity levels in some areas increased when surface water flows fell, and dissolved oxygen necessary for aquatic animal life also fell. Clearly the availability of water to supply human needs should be a consideration in growth and development planning at the local level in advance of applications to appropriate. And needs for irrigation should be considered in cropping practices in agriculture.

Surface Water Withdrawals

Statewide Range of Indicator Values

High	Low
West (3500.01 Mgd)	Multiple (0.00 Mgd)
Chesapeake Bay	Watersheds

Surface Water Withdrawals



Prepared by: Maryland Department of Natural Resources - 1999

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin in units of million gallons per day (Mgd).

Ground Water Withdrawals

The Indicator

Ground water is used for the same purposes as surface water—agriculture and the variety of residential, commercial and industrial uses incorporated in the term “urban.” This water use is also permitted by the Maryland Department of the Environment (MDE). Information for the ground water withdrawal indicator was derived from a file developed by MDE’s Water Rights Division and incorporates permits issued through 1998.

Interpretation

Although only a small fraction of the water withdrawn in Maryland, statewide, is derived from ground water sources, in the Lower Eastern Shore Tributary Basin more than 70% of water appropriated for human uses is derived from these sources. As is the case with surface water withdrawals in the basin, the great majority of this water is used for agriculture—only in the Salisbury area does urban water use account for more than half the amount of ground water pumped. It seems possible that the 1999 drought may see an increase in the installation of irrigation systems dependent on ground water. While water for domestic (urban) uses is in most cases withdrawn from deep aquifers, water for agricultural purposes is much more likely to be drawn from the water table aquifer, which is also the source of base flow in the streams.

Indicator Use


As with surface water sources, the availability and quality of ground water to supply human needs should be a consideration in growth and development planning at the local level for areas where ground water is the source of supply. Needs for irrigation should be considered in cropping practices in agriculture. And the potential impacts on base stream flow should be considered in permitting withdrawals from shallow ground water, such as those for irrigation.


Ground Water Withdrawals


Statewide Range of Indicator Values

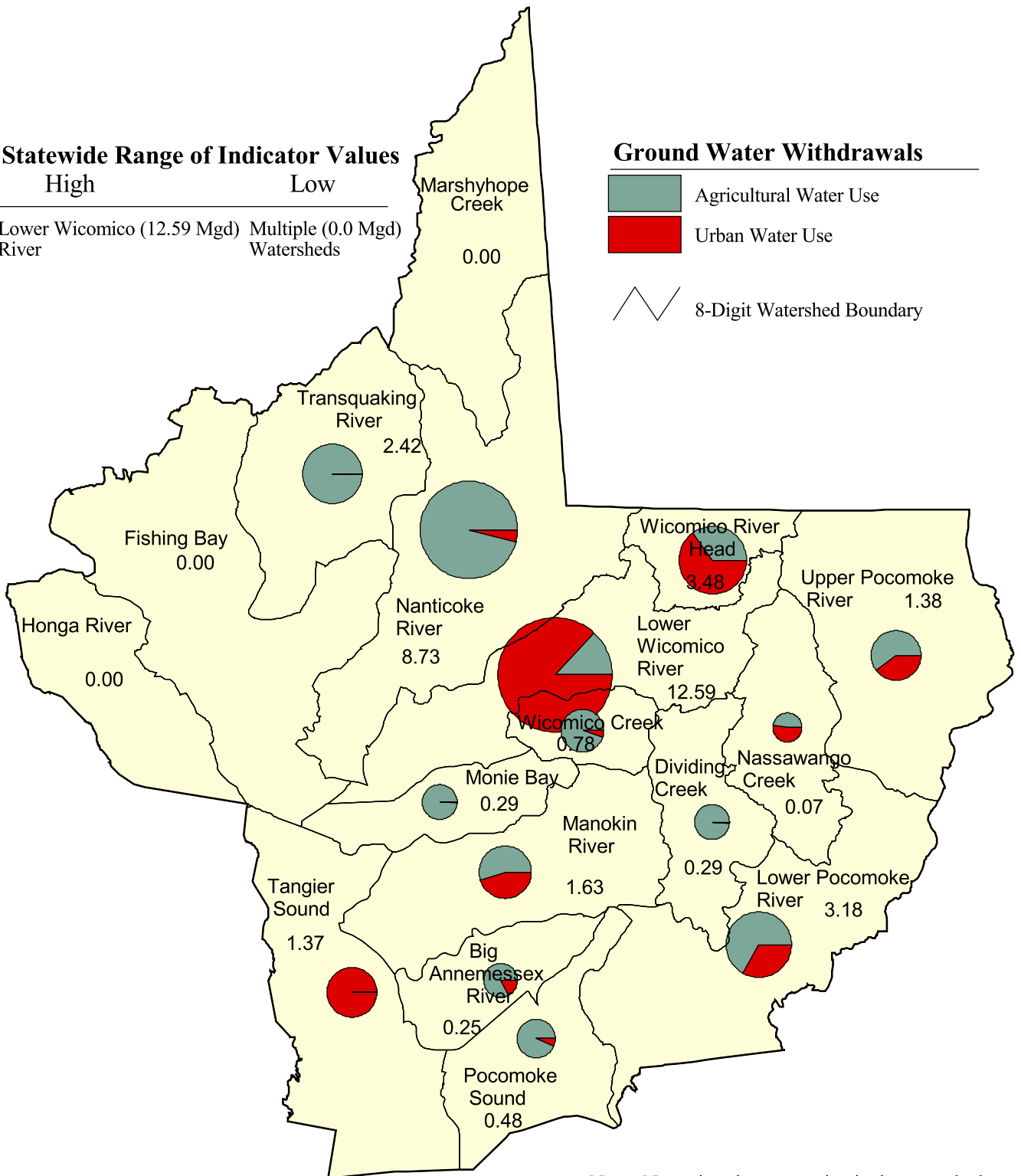
High	Low
Lower Wicomico (12.59 Mgd) River	Multiple (0.0 Mgd) Watersheds

Ground Water Withdrawals

 Agricultural Water Use

 Urban Water Use

 8-Digit Watershed Boundary



Prepared by: Maryland Department of
Natural Resources - 1999

Note: Numeric values appearing in the watersheds
represent total groundwater extraction in
units of million gallons per day (Mgd).

December 1999

Summary of Hydrology Indicator Values

In the Lower Eastern Shore Tributary Basin the most significant disruption to natural hydrologic process arises from the loss of wetlands, often through the establishment of drainage ditches. The Pocomoke River in its entirety stands out for the magnitude of wetland loss that has occurred there. While in more heavily developed watersheds the Impervious Surface indicator might be the major factor in identifying a need for restoration of hydrologic function, in the Lower Eastern Shore it is the loss of wetlands that points most clearly both to the need and to possible opportunities for restoration, since wetland function can be more readily established where wetlands historically existed. Only in the two Wicomico River watersheds in the Salisbury area is impervious surface a significant factor in hydrologic function.

Table 3
Watersheds and Hydrology Indicators

Watershed Name	Wetland Loss (ac)	Impervious Surface	Surface Water Withdrawal (mgd)	Groundwater Withdrawal (mgd)	* Number of Times in Lowest-rated 25%
Nanticoke River	54,807	Fair	3.20	8.73	3
Lower Pocomoke River	71,922	Fair	0.74	3.18	3
Lower Wicomico River	42,358	Poor	0.35	12.59	2
Wicomico River Head	16,145	Poor	0.00	3.48	2
Transquaking River	37,925	Fair	7.29	2.42	2
Tangier Sound	3,517	Fair	0.96	1.37	1
Upper Pocomoke River	80,903	Fair	0.02	1.38	1
Manokin River	43,036	Fair	0.38	1.63	1
Fishing Bay	56,129	Fair	0.01	0.00	1
Marshyhope Creek	28,117	Fair	1.96	0.00	1
Big Annemessex River	15,631	Fair	0.37	0.25	0
Nassawango Creek	34,332	Fair	0.00	0.07	0
Pocomoke Sound	24,264	Fair	0.09	0.48	0
Wicomico Creek	16,422	Fair	0.00	0.78	0
Dividing Creek	34,709	Fair	0.00	0.29	0
Monie Bay	13,799	Fair	0.00	0.29	0
Honga River	10,203	Fair	0.00	0.00	0

* Impervious Surface Rankings other than "Fair" were considered to place the watershed in the lowest - rated 25 % of watersheds in the Basin.

Aquatic System

Aquatic systems include the entire range of plants and animals found in a water environment. Some of these water environments are tidal—subject to the ebb and flow of the tide—and some are free-flowing streams or other non-tidal water bodies like lakes or ponds. The living organisms are dependent on the physical and chemical characteristics of their habitats as well as upon interactions among the biological elements of the system. Living organisms include plants, such as algae and the Bay grasses referred to as SAV that provide food and protective cover for many species; *benthic*, or bottom-dwelling, organisms; and animals which move freely through the water. The aquatic system includes animals necessary in the food chain of higher levels of animals, as well as the fish, shellfish and crustaceans which play such an important part in Maryland's image and help to support its economy. Health of aquatic systems depends upon the successful functioning of all of these components in physically and chemically supportive habitats. Because of its critical importance in aquatic systems and a long history of public concern and programmatic action, water quality is treated as a separate topic in this report.

Ecological processes are of concern in dealing with entire systems, not just the individual component species: flows of energy and cycling of materials are sustaining ecological processes; biological processes of reproduction, growth and decay must be supported in suitable habitats; predator-prey relationships between species need to be in balance. Again, because of its critical importance in the health of aquatic systems, hydrologic function—the way water flows through the system—is treated separately.

Stressors and Sources

Aquatic systems are degraded chemically by the input of various pollutants, including organic materials and nutrients from industries and sewage treatment plants (points), and from nonpoint sources like urban and farm run-off and atmospheric deposition. Toxic materials from a variety of sources may also affect aquatic organisms. These aquatic systems are altered or degraded physically by erosion and efforts to control erosion, by sedimentation, temperature and salinity changes, dredging, filling and channel modifications. Some of these impacts are naturally occurring; some are due entirely to human activity; most are at least aggravated by human activities. Biological degradation occurs when the effects of chemical and physical degradation, and in some cases harvesting by humans or attack by disease organisms, interact with the living species present in the system, affecting some directly and impacting others through changes to the overall community composition or interference with ecological processes.

High nutrient levels have been identified as the major water quality problem causing degradation of tidal aquatic systems in Maryland. They cause algal blooms (cloudy water resulting from excessive microscopic plant growth) and epiphytic growth (small plants that grow on the SAV) which harm these grasses by reducing the amount of light reaching them. Epiphytic growth also aggravates mechanical stress on the SAV, contributing to breakage under wave action. And as

the algae decay, they use dissolved oxygen in the water, stressing or outright killing necessary benthic organisms and other desirable species.

Non-tidal aquatic systems are perhaps even more susceptible to physical degradation than tidal systems are: in addition to erosion and sedimentation, dredging and channel modifications (often in the name of flood control), physical degradation includes reductions in *base flow*, the amount of water flowing in streams between rain events, and thermal effects from removal of forests along shorelines. The systems are often fragmented by development of roads or other transportation facilities, reducing upstream-downstream movement of aquatic species. Hundreds of miles of streams tributary to the Chesapeake Bay are currently blocked by dams, culverts and other obstructions. Anadromous fish, such as shad and river herring, rely on access to freshwater streams with suitable bottom and current for spawning.

Changes in the landscape, like increasing urban development and additions to the transportation system, often accelerate nutrient and toxics delivery to aquatic habitats and lead to physical degradation as well. For example, urban landscapes without adequate vegetation lack nutrient retention capacity and contribute excess nutrients downstream. Particularly important are the increases in hydraulic efficiency provided by paving large areas and providing storm sewers and ditches to speed the movement of water, and associated nutrients and contaminants, away from buildings or other human use areas. Activities on the land also cause increased inputs of sediment both from clearing and grading activities and from the effects of increased runoff on streambanks, further clouding the water and affecting light penetration; sedimentation also can blanket the bottom, affecting bottom-dwelling organisms and the habitat necessary to support them.

Desirable food species, including shad, crabs and striped bass, are or have been stressed at times by over-harvesting; in some cases their reproduction has been affected by landscape change, while alterations in plant composition has disrupted the food supply, particularly for filter-feeders. Oysters, important to water quality in their role as filter-feeders as well as to the economy, have been severely hurt in recent years by the parasites MSX and Dermo and can be affected by salinity levels in the Bay. These, in turn, may vary with weather conditions, clearly outside the reach of any of the State's management programs.

Lower Eastern Shore Issues

The Steering Committee for the Lower Eastern Shore Action Strategy identified four primary issues related to aquatic systems, in addition to the issues identified above as relating to water quality and efforts to deal with pollution sources. There was discussion of the issue of sea level rise, and its impacts on aquatic and coastal wetland systems, but the consensus was that this issue was one which extends far beyond the Lower Eastern Shore and for which there is no programmatic response from State or local governments.

- Coliform bacteria from a variety of sources affect the health of aquatic living resources and, more significantly, the safety of human consumption of these resources and, thus, the economies dependent upon their harvest.
- Oyster population and health are critical in both ecological and economic terms and are affected by both natural (e.g., disease) and human-induced impacts (for example, bacterial contamination) to their habitat.
- Toxic outbreaks of *Pfiesteria piscicida*, such as occurred in the summer of 1997, resulted in both severe fish health and human health impacts.
- Loss of submerged aquatic vegetation (SAV) interrupts the food cycle and indicates a loss of cover for other aquatic species, at least during important phases of their life cycles.
- Stream buffers—whether they must be forested to provide ecological benefits or whether grassed areas can provide these benefits as well.

Management Programs

A variety of programs at the State level, or local-State partnerships, have been developed to address issues related to aquatic ecosystems and their components. These programs are primarily non-regulatory in nature, focusing mainly on monitoring and improving the science used in decision-making or carrying out physical projects to restore impaired system function. Several arise from the interstate-federal Chesapeake Bay Program.

- ***Fish Passage projects*** (DNR) result in removal of blockages to anadromous fish. Although current priorities for this program are not in the Lower Eastern Shore Tributary Basin, rivers other than those where the program is focused can receive attention as opportunities arise.
- ***Oyster Recovery*** (DNR) activities focus on working cooperatively with the Oyster Recovery Partnership to enhance areas of the Bay and tributaries for oyster bar creation for both harvesting and sanctuaries.
- ***Buffer Incentive Program (BIP)*** (DNR) provides a onetime \$300 per acre grant to landowners who plant and maintain forested buffers along watercourses for a minimum of ten years.
- ***Small Creeks and Estuaries Water Quality Restoration Program*** (MDE) provides financial assistance to local governments for restoration projects in seriously degraded water bodies in older developed areas of the State.
- ***Critical Area Program*** provides for much reduced development in a 1000-foot band around tidal waters and tidal wetlands, including a 100-foot buffer immediately along the water pr wetland edge that is to be retained in vegetation.
- ***SAV Restoration Partnership*** (DNR) coordinates and implements SAV restoration activities at suitable sites with the assistance of interested citizens.
- ***Coastal Zone Management program*** (DNR), through partnerships and funding to local governments, state agencies, non-profit organizations and universities, addresses a variety of coastal issues including provision of public access, nonpoint

source pollution reduction, coastal hazards mitigation, habitat and living resources protection and growth management.

- ***The Coastal and Watershed Resources Advisory Committee (CWRAC)*** provides a voice for local citizens and the Counties to discuss matters of concern.
- ***The Conservation Reserve Program (FSA)*** provides rental payments of up to \$50,000 to farmers who will take sensitive lands out of production for 10 to 15 years, and incentive payments to install improved cover on the lands and for riparian area wetlands creation. The intent is to reduce erosion and sedimentation in order to improve water quality and to enhance fish and wildlife habitat.

Several programs affecting aquatic systems have been developed by private non-profit organizations, some of them having at least potential relevance to restoration and conservation needs in the Lower Eastern Shore Tributary Basin.

- ***Chesapeake Bay Foundation-Ducks Unlimited Habitat Restoration Program*** is a cooperative effort seeking to restore streambanks in the Chesapeake Bay watershed. The focus is on protecting wetlands, establishing buffers and preserving habitat for wildlife, especially migratory birds.
- ***Save Our Streams*** (Izaak Walton League of America) runs several programs to mobilize volunteers and provide low- or no-cost technical assistance to governments, businesses, individuals and groups involved in stream cleanup and restoration.

Program Issues and Observations

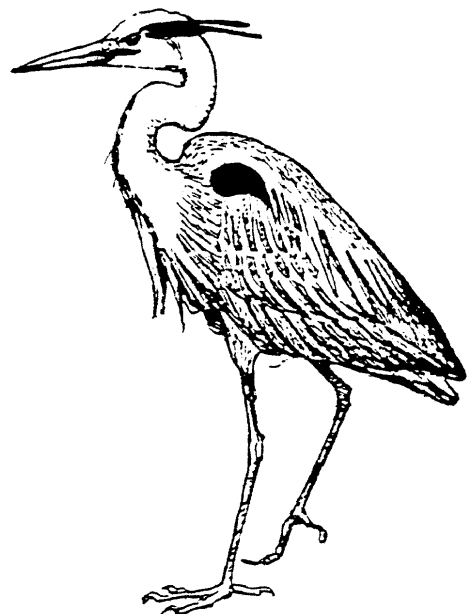
- ✓ Tributary Strategies program has been useful in trying to educate the population with workshops. Local participation is limited by the perception that the agendas are driven by the State and that there is too much emphasis on agriculture. Also, the Lower Eastern Shore Tributary Team would benefit by greater funding support for implementation projects.
- ✓ CWRAC has been supportive of local efforts. The Coastal Zone Management program was effective in the past in supporting local projects and studies, but most funds have now been diverted into funding the Critical Area program.
- ✓ Most programs at the local level are permit-driven—if there is no new development, restoration opportunities (e.g., stream buffer planting) don't arise. The exception is the Critical Area program, where local governments may respond to activities beyond the permit phase. The Critical Area Program, however, was criticized for “second guessing” local governments, and for making it hard for local governments to provide the same level of protection outside the Critical Area because of the “1000 foot line in the sand”.

- ✓ The Critical Area Program has its regulatory handle primarily in the subdivision and building permit phase of activity. Education of waterfront landowners is necessary to ensure that natural waterfront values are maintained after development occurs.
- ✓ Incentive payments are often seen as insufficient to encourage desirable actions. For example, the cutting of Buffer Incentive Program payments from \$500 per acre to \$300 has been accompanied by a drop in usage of the program statewide. Excessive “bureaucratic red tape” was also cited as hindering implementation,
- ✓ Paperwork for some incentive programs is often seen as burdensome, limiting their use.
- ✓ The need for more effective mechanisms to educate and enlist citizens in restoration efforts was cited as a major frustration by some program managers. There is a perceived lack of organized and coordinated citizen volunteer efforts, as well as a lack of functioning groups with which to work.
- ✓ The process for receiving funds through MDE’s Small Creeks and Estuaries Program was cited as being cumbersome and a deterrent to potential applicants. Several local government program managers stated that they would like to see more monetary support from DNR’s Coastal Zone Management Program, which had historically given more funds than at present to local governments for planning and management activities.

The Indicators

Seven of the indicators that have been chosen to evaluate aquatic system health and functioning deal with the biological, chemical and physical resources of the waters themselves, both tidal waters and non-tidal. Two additional indicators relate to the adjacent land areas. These are included in this section because of their importance to maintaining non-tidal aquatic system integrity, although their importance as terrestrial systems, too, should not be overlooked.

- Tidal water quality–eutrophication
- Tidal water quality for habitat
- Submerged Aquatic Vegetation habitat
- Submerged Aquatic Vegetation health/abundance
- Migratory fish spawning index
- Unforested riparian buffer
- Non-tidal instream physical habitat
- Non-tidal benthic Index of Biotic Integrity
- Percent of headwater streams in core forest



Water Quality Eutrophication Index

The Indicator

Eutrophication is the over-enrichment of a body of water with too many nutrients, resulting in excessive accumulation of organic material. This accumulation of organic material alters the trophic structure (food web) of the water body. Changes in the trophic structure lead, in turn, to changes in species composition, often to less desirable species, such as a shift from larger green algae (a nutritious food source for filter feeders such as oysters) to dinoflagellates (which can be toxic) and bacteria, which are too small to be eaten by filter feeders. Eutrophication occurs in nature, but it happens very slowly. Human activities that cause excess nutrients to enter our waterways speed up the eutrophication process.

This new Water Quality Eutrophication Index, which is still undergoing testing, combines information on three parameters that help to measure the level of eutrophication in tidal tributaries: total nitrogen in the surface mixed layer (the nitrogen available to algae), total phosphorus, and total suspended solids. Using 1994-1996 data, relative water quality status scores for the three components were combined into a single number from 1 to 10, where 1 indicates the worst condition (most eutrophied) and 10 indicates the best condition (least eutrophied). These numbers were further combined into an overall index, averaged by station. For 8-digit watersheds that included more than one station, these overall index averages by station were again averaged to determine the watershed index.

Interpretation

For the Unified Watershed Assessment, watersheds were classified as in need of restoration if their scores for the Eutrophication Index were in the lowest 25% (quartile) of scores statewide. In the Lower Eastern Shore Tributary Basin, the Nanticoke River, Manokin River, Fishing Bay and Pocomoke Sound watersheds were classified in the lowest statewide quartile, indicating that they are in need of restoration. No watersheds in the State were considered pristine in terms of this indicator.

Indicator Use

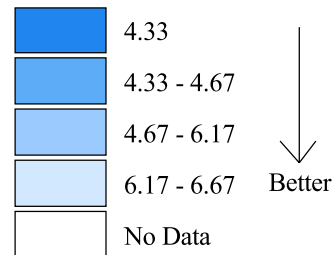
From a research perspective, consolidation of data into this Eutrophication Index results in an oversimplified but consistent indicator. The combination of the relative status scores for each of the individual parameters is a first cut at assessing the relationship between multiple variables, expressed in a comprehensible single term, and serves as a relative indicator of ecosystem health. Used in conjunction with other data, the index helps to identify areas where restoration efforts might be most fruitful in terms of living resources goals.

Water Quality Eutrophication Index

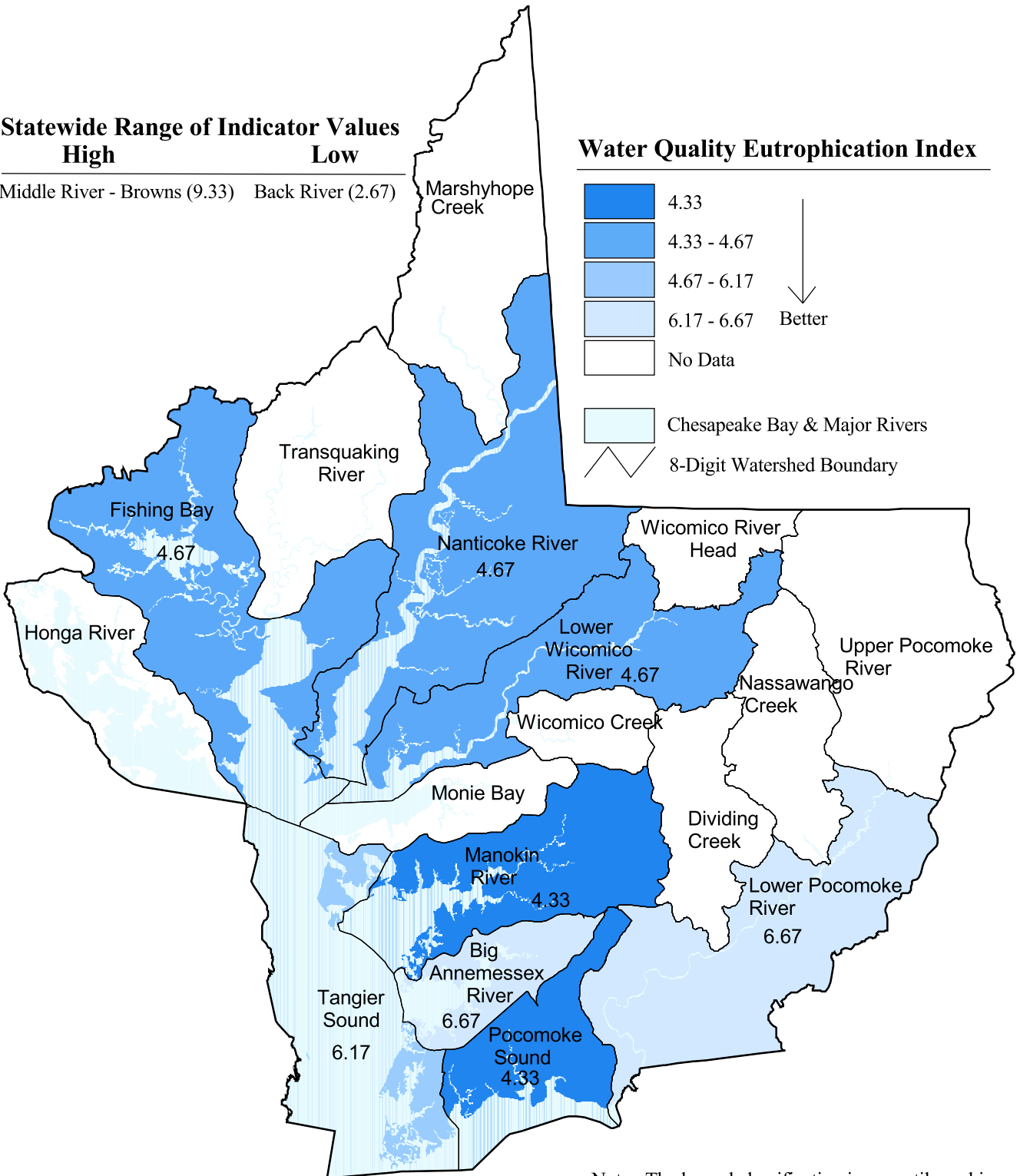
Statewide Range of Indicator Values

High Middle River - Browns (9.33) **Low** Back River (2.67)

Water Quality Eutrophication Index



Chesapeake Bay & Major Rivers
8-Digit Watershed Boundary



Prepared by: Maryland Department of
Natural Resources

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Water Quality Habitat Index

The Indicator

Living resources depend on their habitats—physical, chemical and biological—for their survival and health. The Water Quality Habitat Index incorporates information on the status (1994-1996) for three parameters important in judging the habitat quality of estuarine waters: abundance of algae, water clarity, and dissolved oxygen levels. Abundance of algae is estimated using surface chlorophyll *a* levels, water clarity is measured using secchi disk depths, and dissolved oxygen is measured in bottom waters during the summer months (July - September). It should be noted that this Water Quality Habitat Index is relatively new and untested. The relative importance of the components of this index depends on the living resource under consideration. For example, plants are strongly affected by water clarity but less affected by dissolved oxygen, whereas the opposite is true of oysters. Of the three components, only dissolved oxygen has a numerical standard against which status is scored. For the other components, status is determined based on a relative scale.

The status scores of the three individual components were converted to a single score from 1 to 10, where 1 represents most degraded (habitats in the worst condition) and 10 represents the best condition. This score was then combined into an overall mean for each sampling station. For 8-digit watersheds that included more than one station, the overall station scores were then averaged to determine the watershed mean. For the Unified Watershed Assessment, watersheds were considered to be in need of restoration if their scores fell in the lowest 25% of scores statewide.

Interpretation

Among the Lower Eastern Shore Tributary Basin watersheds, the Lower Pocomoke River and Lower Wicomico River both scored in the lowest quartile statewide, rating them in need of restoration. Although no watershed in the State was rated as pristine in terms of this indicator, it should be noted that the Big Annemessex River watershed in the Lower Eastern Shore received the highest score statewide.

Indicator Use

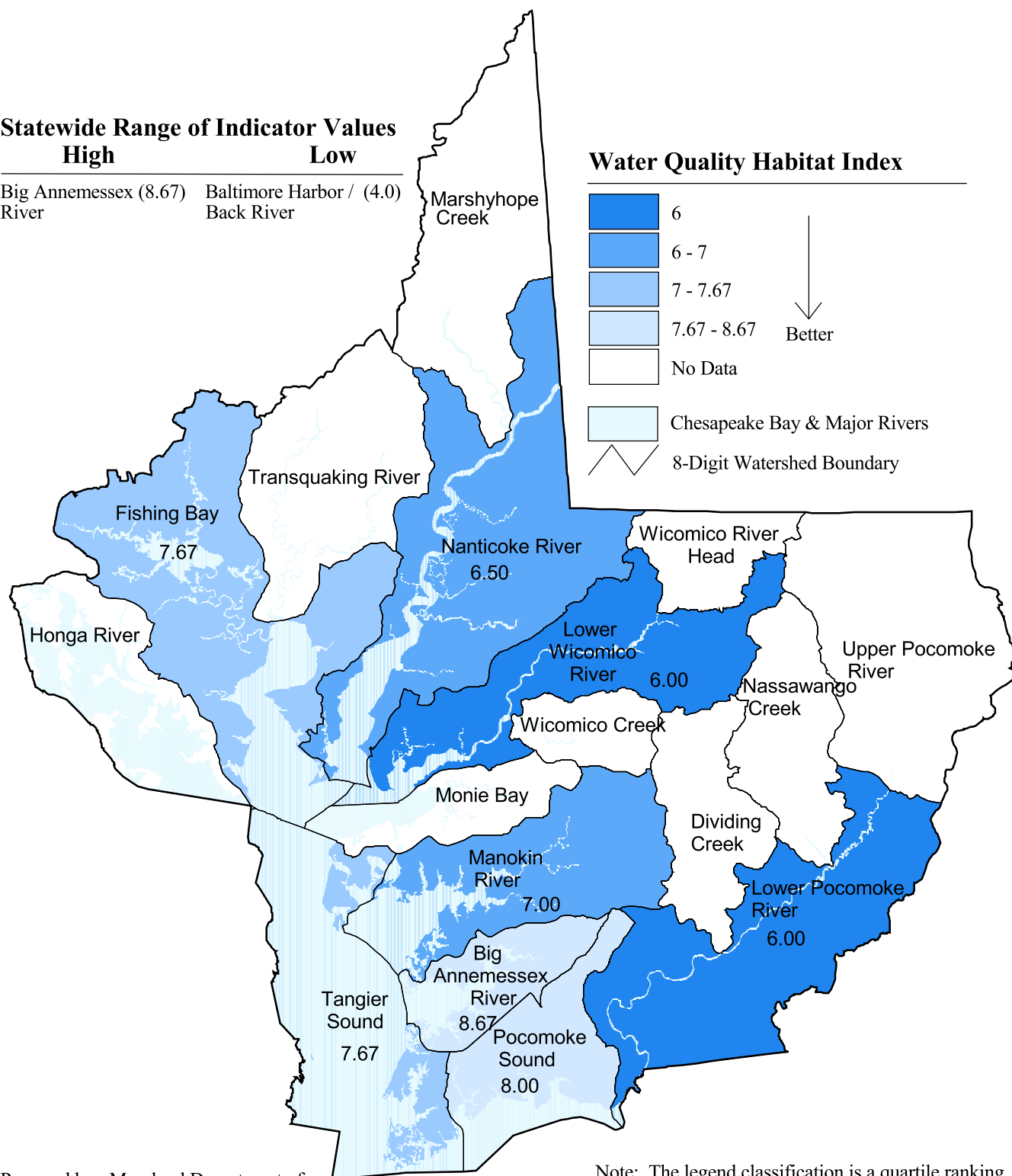
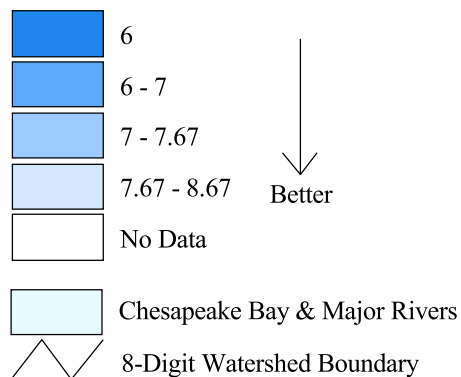
Protecting and restoring water quality is linked to the ultimate goal of maintaining the health and viability of the living resources in our waters. The Water Quality Habitat Index offers a first cut at making that connection explicit by combining several types of data to identify watersheds that are in trouble from a very general living resources perspective—habitats are degraded. When used in conjunction with other indicators, the Water Quality Habitat Index points to watersheds where concerted programmatic efforts might be most advantageous for restoring ecosystem function.

Water Quality Habitat Index

Statewide Range of Indicator Values

High	Low
Big Annemessex (8.67) River	Baltimore Harbor / (4.0) Back River

Water Quality Habitat Index



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Submerged Aquatic Vegetation (SAV) Habitat Index

The Indicator

Submerged aquatic vegetation (SAV)—often called Bay grasses—is a key component of aquatic ecosystems, providing food and shelter for many species, particularly in the more vulnerable stages of their life cycles. SAV also plays a role in moderating the effects of storms and boat wakes on shoreline erosion. Important goals of the Chesapeake Bay restoration program focus on SAV, in Virginia as well as Maryland, and figures for SAV acreage are reported annually for the entire Bay. To survive, much less thrive, Bay grasses require light and suitably low nutrient levels in the water. This habitat condition indicator identifies areas providing adequate habitat to 1 meter depth for SAV.

To develop this indicator, Chesapeake Bay Program Bay segments were assessed using 1994 to 1996 data and were scored as passing, failing or borderline for SAV habitat requirements: Secchi depth (a measure of water clarity), dissolved inorganic nitrogen, dissolved inorganic phosphorus, chlorophyll *a* (a measure of algae), and suspended solids. In some areas only four habitat requirements apply; dissolved inorganic nitrogen habitat requirements do not apply in tidal fresh and oligohaline, or very low salinity, areas. Scores for each segment are a composite based on all applicable habitat requirements.

Interpretation

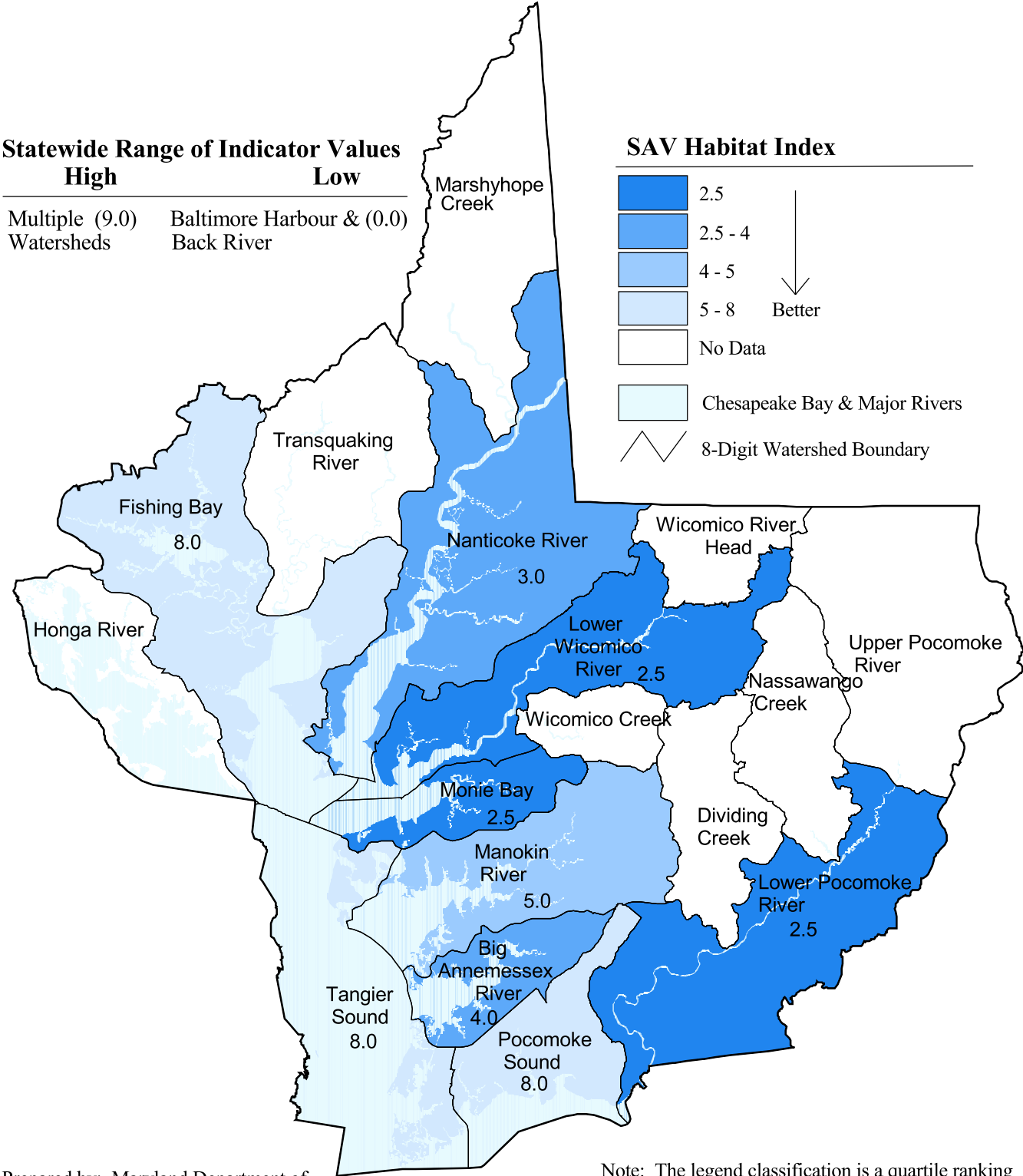
Scores are adjusted to range between 1 and 10 (1 being most degraded, 10 representing the best condition). No area in Maryland is considered to be pristine in terms of SAV habitat quality. For the Unified Watershed Assessment, watersheds were identified as needing restoration if they are scored lower than 7. Watersheds scored 7 or higher were considered to justify preventive measures in order to maintain their relatively good condition. To score this high, all parameters for a segment had to be assessed as at least borderline in quality.

Many watersheds in Maryland, including several in the Lower Eastern Shore Tributary Basin, have no data for this indicator. Only Fishing Bay, Pocomoke Sound and Tangier Sound watersheds are assessed as having fairly good quality. The continuing decline of Bay grasses in Tangier Sound is particularly puzzling in light of this assessment of habitat quality there.

Indicator Use

Areas of better habitat quality for SAV offer potential candidates for early efforts to re-establish Bay grasses through physical interventions, such as transplantation. Components of the score that account most for low values in an individual watershed suggest particular needs for water quality improvement and the types of actions in the watershed that might lead to this improvement.

Submerged Aquatic Vegetation Habitat Index



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Submerged Aquatic Vegetation (SAV) Abundance

The Indicator

In part because of their high visibility and sensitivity to water quality, Bay grasses form a component of all reports on Bay condition, such as the Chesapeake Bay Foundation's annual report card on the Bay.

The condition of the State's Bay grasses is determined by measuring the number of acres where SAV is found growing each year. SAV coverage is assessed from aerial surveys and quantified by Chesapeake Bay Program segments using digital techniques. These coverage estimates are compared to the SAV Restoration Goals—ultimately to reestablish SAV in all suitable areas of the Bay up to two meters in depth—to determine progress towards restoration of healthy SAV populations. Each tributary has its own SAV restoration goals, based on the area expected to be available for SAV growth as determined by water depth, physical characteristics such as sediment type and wave exposure, and historic occurrence of SAV. One limitation to this technique is that the altitude of the aerial surveys is 12,000 feet, which causes the surveys to miss SAV in smaller rivers.

Index values for this indicator could range from 1 to 10, with 1 being the least favorable condition and 10 being the best. To calculate the index, the acreage found in the 1996 aerial survey was divided by the target acreage (SAV to 2 meters depth), and the resulting percentage was multiplied by 10. As a result of rounding, 1 is the lowest value assigned any watershed.

Interpretation

No tributary in the Lower Eastern Shore scored above 1 for this indicator, meaning that none had more than 10% of suitable area observed to be covered with Bay grasses. To provide some perspective on this number, it should be pointed out that no watershed in the State scored higher than 2, reflecting a maximum observed coverage of 20%, and several tidal rivers, or portions, likely never had SAV. There is particular concern at the State level over continuing annual declines in SAV in Tangier Sound at a time when the picture is improving elsewhere, particularly on the western shore. The SAV in Tangier Sound has historically provided critical refuge for immature blue crabs and, with other areas, refuge for mature blue crabs during molting.

Indicator Use

Because SAV is such a critical component of a healthy Bay ecosystem and also can, in open water, be readily identified from aerial surveys, this indicator is used by State agencies and in the Chesapeake Bay Program, and by private groups such as the Chesapeake Bay Foundation, to gauge annual and long-term fluctuations in Bay health.

Submerged Aquatic Vegetation Abundance

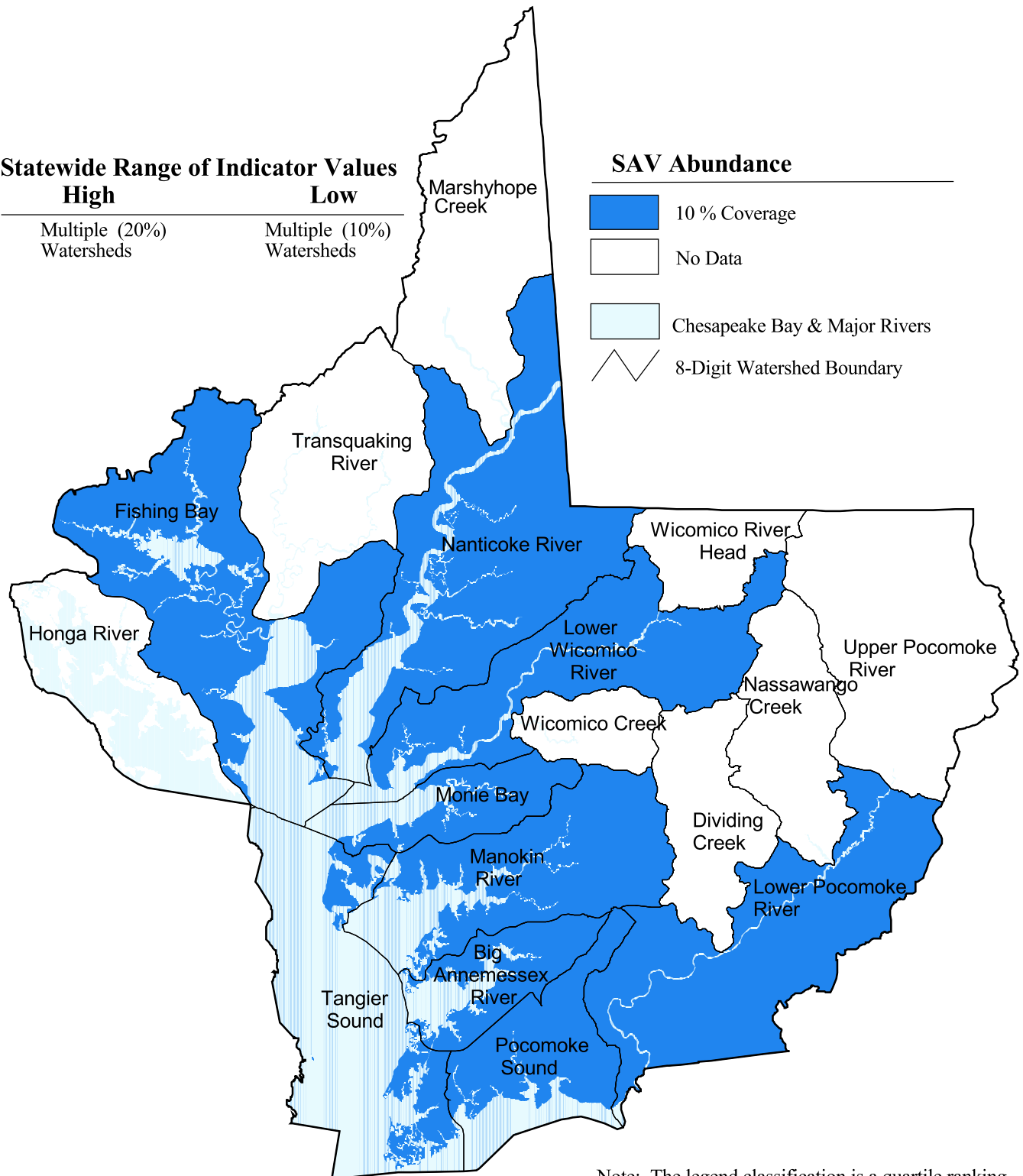
Statewide Range of Indicator Values

High
Multiple (20%)
Watersheds

Low
Multiple (10%)
Watersheds

SAV Abundance

- 10 % Coverage
- No Data
- Chesapeake Bay & Major Rivers
- 8-Digit Watershed Boundary



Prepared by: Maryland Department of
Natural Resources

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Migratory Fish Spawning Index

The Indicator

A number of the most valuable fish species found in the Chesapeake Bay must migrate up tributary streams to spawn. This living resources indicator rates watersheds based on the diversity of spawning habitat for American Shad, Hickory Shad, Alewife, Blueback Herring, White Perch, Striped Bass, and Yellow Perch. It deals with a highly valued function of non-tidal streams and for this reason can be considered an indicator of vulnerability to human-induced damage. It also reflects the condition of the resource. The Migratory Fish Spawning Areas indicator was developed using Maryland DNR Fisheries Service information and *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk et al. 1991).

This indicator scores watersheds based on the number of migratory fish species from 0 - 7 that spawn within the watershed; it was used in the Unified Watershed Assessment to help identify watersheds that are candidates for conservation and protection. A caveat is in order about this indicator in that it focuses only on the number of species, without consideration of the local rarity or economic value of particular species. This indicator responds to physical blockages from dams, road culverts etc., to water quality impairment, or to combinations of these factors.

Interpretation

The Nanticoke River-Marshyhope Creek system and the Lower Wicomico River watershed have comparatively high scores for this indicator; the Marshyhope and Nanticoke rank among the top 25% of streams statewide. While the construction of dams for water powered mills is a primary cause of stream blockage on the western shore of the State, resulting in long term decline of migratory fish species, Lower Eastern Shore rivers have very low gradients and were historically unsuited for locating mills.

Indicator Use

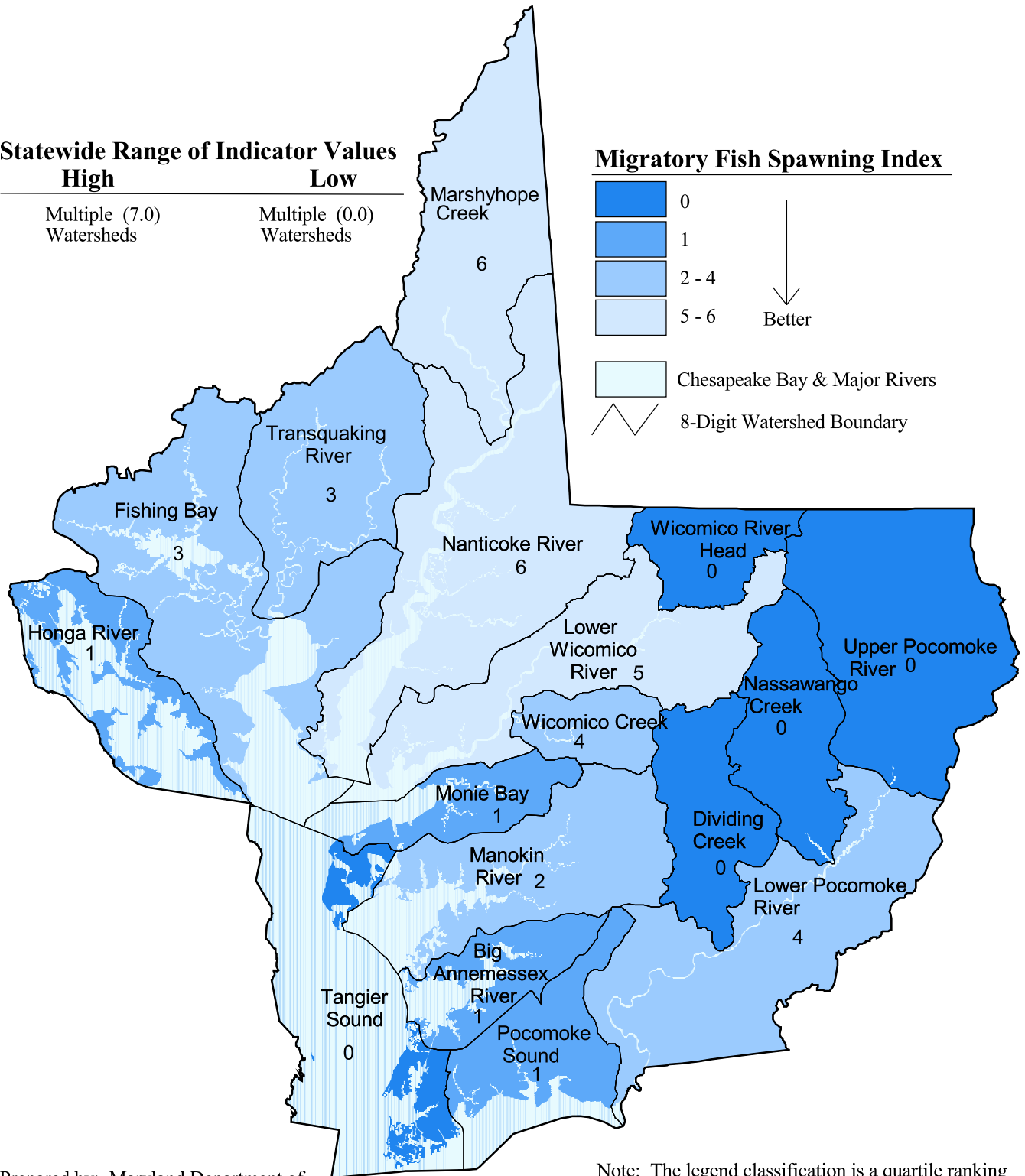
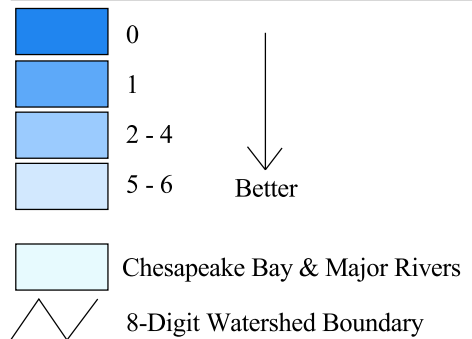
Conservation organizations can use this indicator to help target areas (i.e., watersheds with high ratings) in which to acquire fee simple ownership or conservation easements. Lower ratings suggest, to groups interested in restoration opportunities, places to look for causes like physical blockages that might be corrected or improved or for water quality problem areas which are correctable.

Migratory Fish Spawning Index

Statewide Range of Indicator Values

High	Low
Multiple (7.0) Watersheds	Multiple (0.0) Watersheds

Migratory Fish Spawning Index



Prepared by: Maryland Department of
Natural Resources - 1999

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Percent Unforested Riparian Buffer

The Indicator

Many ecological benefits are associated with maintaining forest along streams—riparian forest. These include taking up nutrients in ground and surface water flow, as a buffer between streams and adjacent land uses; stabilizing stream banks; shading the water and maintaining its temperature; and providing food for aquatic and terrestrial animals alike. The presence of unforested riparian areas is an indicator of aquatic and terrestrial system stress within a watershed.

A Geographic Information System (GIS) was used to calculate the amount of forested and unforested riparian buffer in each watershed. First a 100 foot stream corridor (buffer) was identified around free-flowing streams mapped by the Maryland Office of Planning (OP). This information was combined with OP 1994 land use data showing forested land and with DNR's Forest Resource Inventory (FRI) of 1991. To calculate the indicator, the combined area of forested and unforested corridor was summed for each eight-digit watershed. Then, the unforested portion was divided by the total corridor area to create the percent of unforested riparian buffer.

Interpretation

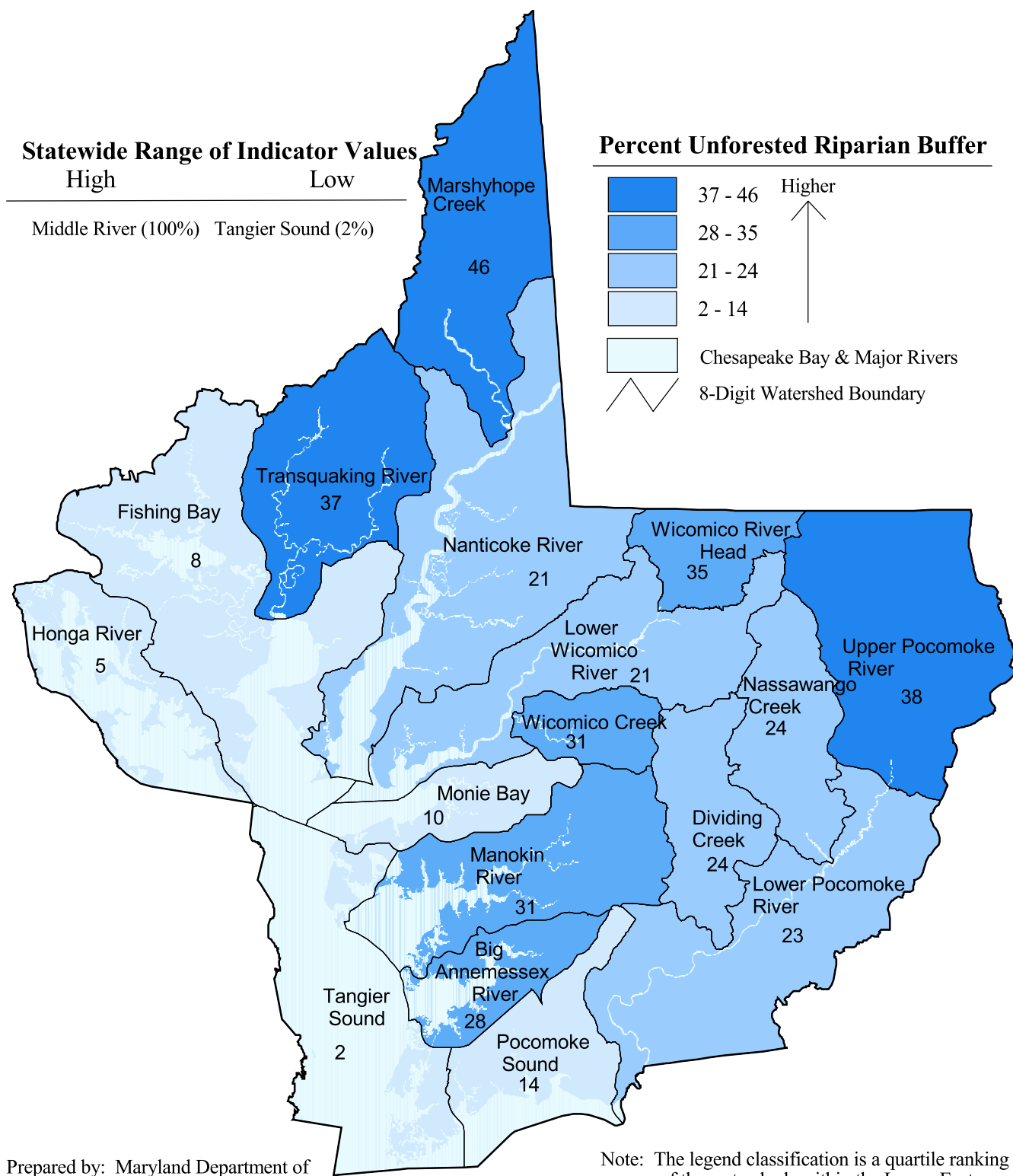
In a natural state, the percentage of unforested riparian buffer should be close to zero; clearly this is not a situation which prevails in the Lower Eastern Shore Tributary Basin. Although Tangier Sound has the lowest unbuffered stream percentage reported statewide, it should be noted that where most of the shoreline areas are estuarine, as is the case in all of those showing the lowest values in the map opposite, this indicator has less relevance than in free-flowing stream corridors.

In the Unified Watershed Assessment, watersheds with more than 49% of stream lengths unforested were considered to be in need of restoration. In the Lower Eastern Shore Tributary Basin, no watersheds were so classified, although the Marshyhope Creek watershed comes close to the cut-off, and the Transquaking and Upper Pocomoke River watersheds also have substantial percentages of unbuffered streams.

Indicator Use

Watersheds having high percentages of unforested land in the riparian area bordering streams are potential targets for riparian reforestation. Where unforested riparian buffer areas represent smaller percentages of stream mileage, other restoration measures may be more appropriate to achieving water quality and habitat improvement.

Percent Unforested Riparian Buffer



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Non-tidal Instream Physical Habitat

The Indicator

Increasing focus in recent years on living resources when considering water quality issues has served to call greater attention to the physical condition of streams as well as their chemical water quality. A physical habitat indicator has been developed for small (first- to third-order) non-tidal streams. The indicator is based on several measures of instream habitat quality that are scored for each site based on observations of habitat condition in streams during sampling visits. The habitat measures rate the quantity and quality of physical habitat available in the stream for fish and benthic macroinvertebrate colonization and rate the degree to which the stream channel has been altered due to changes in watershed landscape.

The physical habitat characteristics are measured, scored, weighted, and summed to calculate the indicator for each sampled stream. A low score, or a decline in score over time, reflects both natural disturbances and human-induced alterations of the stream habitat relative to minimally-disturbed reference sites. The mean habitat score for watersheds is reported on a 1 to 10 scale, 1 being most degraded, 10 representing the best condition. The indicator as applied to Coastal Plain streams such as those in the Lower Eastern Shore Tributary Basin includes five characteristics: instream habitat structure, velocity–depth diversity, pool quality, riffle quality, and aesthetic quality.

Interpretation

Physical habitat conditions in non-tidal streams and rivers are influenced by land use and land cover patterns in the watershed, such as the destruction of riparian forests and increasing the area of impervious land cover. Other major influences are channelization, encroachment by livestock, and blockages to upstream/downstream movements of fish. Several Lower Eastern Shore watersheds exhibit very low physical habitat quality, approaching the statewide low value, and none is highly rated.

Indicator Use

A number of interventions, tailored to specific local conditions, are suggested by low physical habitat scores: control and minimize point and nonpoint sources of water pollution; prevent the depletion of groundwater supplies; minimize the area of impervious land cover; restore riparian forests; keep livestock out of the stream channels; remove blockages to upstream/downstream movements of fish, or construct fish passage structures if the blockages cannot be removed.

Non-tidal Instream Physical Habitat

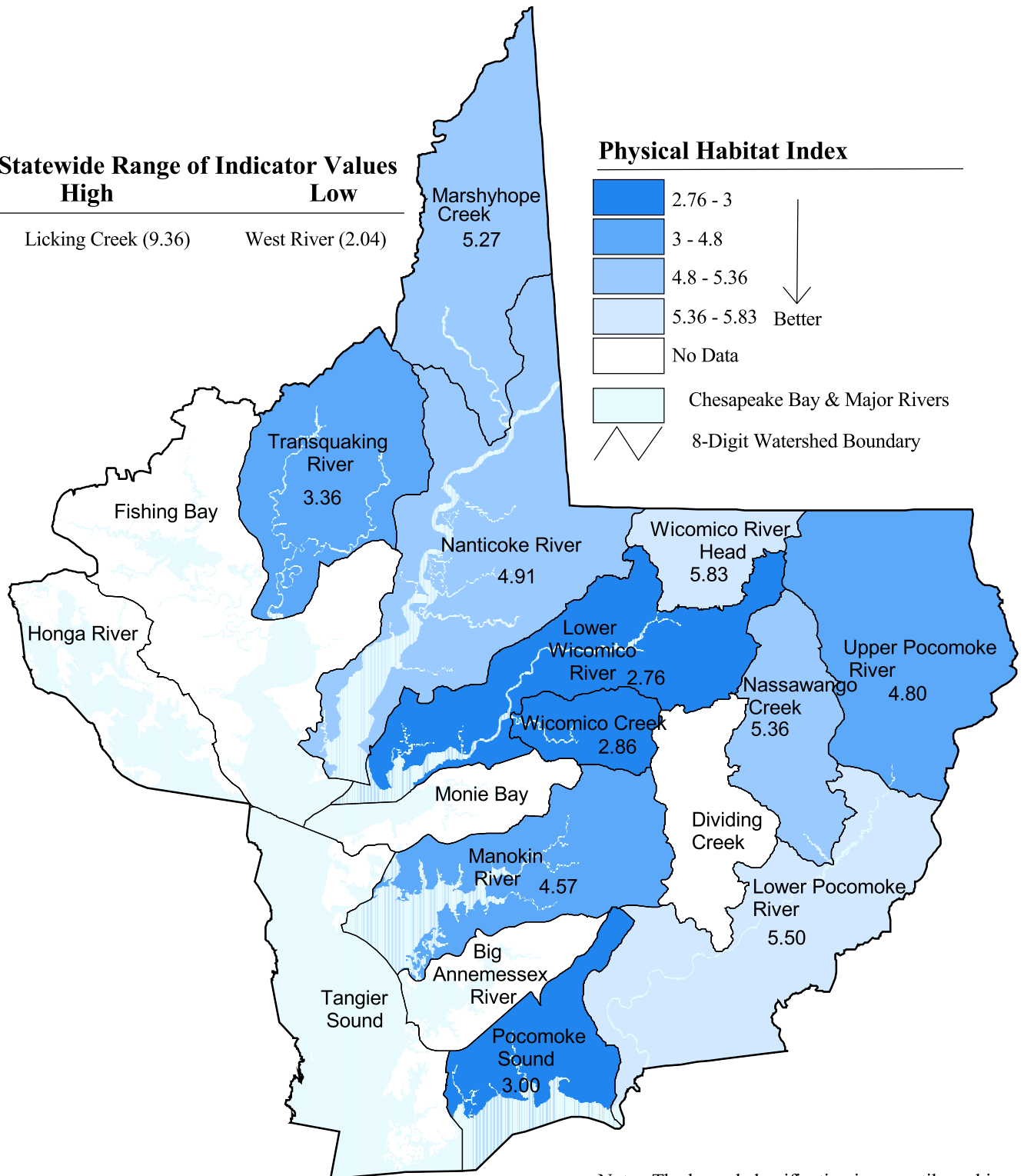
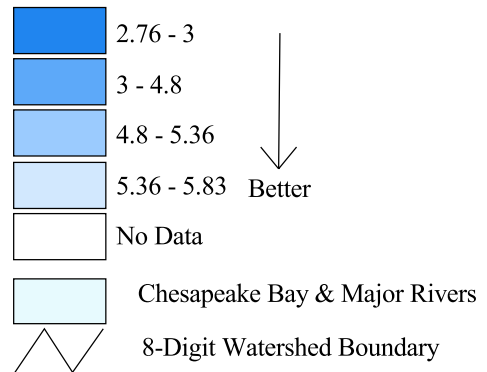
Statewide Range of Indicator Values

High **Low**

Licking Creek (9.36)

West River (2.04)

Physical Habitat Index



Prepared by: Maryland Department of
Natural Resources - 1999

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

http://www.dnr.state.md.us/ccws/surf/Les_InStmHab.pdf

December 1999

Non-tidal Benthic Index of Biotic Integrity (IBI)

The Indicator

Less noticeable to the general public than fish, benthic creatures are essential to the functioning of aquatic ecosystems, including providing much of the food for other species. They are particularly sensitive to changes in water quality and physical habitat. The Benthic Index of Biological Integrity (IBI) has been developed for the first- to third-order non-tidal streams in Maryland. The Coastal Plain stream benthic IBI looks at the insects and other invertebrates, like crayfish, living on the bottoms of streams, considering the overall community composition, the number and diversity of species and the presence of sensitive species. For the benthic IBI, reference conditions were established for minimally-impacted streams. IBI values used in this assessment are relative to conditions in these minimally-impacted streams.

As with the fish IBI, a decline in benthic IBI scores reflects natural variation as well as decreases in water quality and/or physical habitat conditions. Scores for watersheds are reported as means for the sites within each watershed. For purposes of the Unified Watershed Assessment, an original 1 to 5 scale was expanded to a scale of 1 to 10 (1 most degraded, 10 best condition).

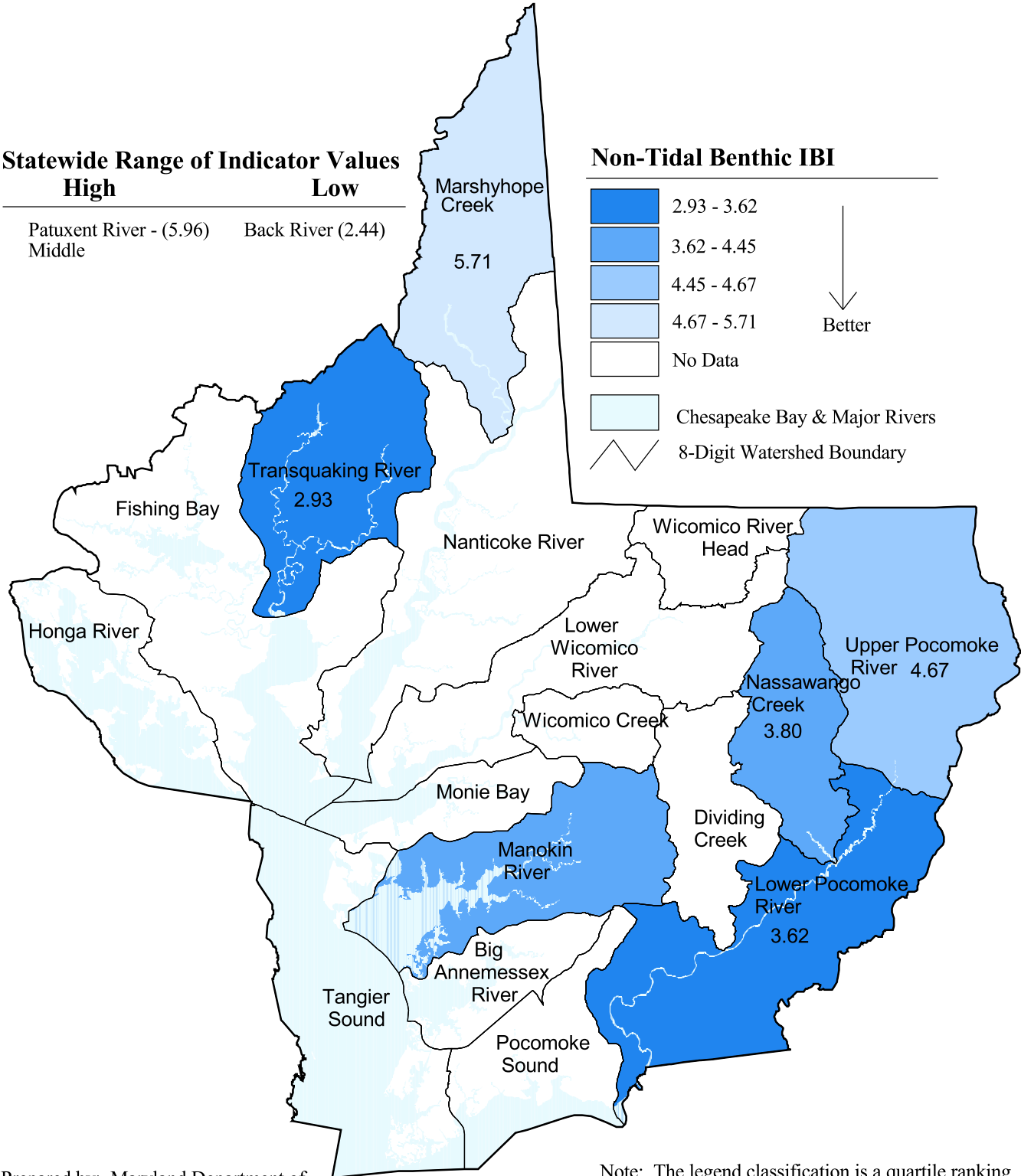
Interpretation

Benthic IBI scores generally were highest in the far western part of the State and in a band through Central Maryland. Statewide, just under 11% of streams were rated as “good,” while over 50% were rated poor or very poor. A score of less than 6 for a watershed where at least four samples were taken placed that watershed in the category calling for restoration under the Unified Watershed Assessment completed for Maryland in the summer of 1998. All but two of the watersheds in the Lower Eastern Shore Tributary Basin, the Nanticoke River and the Wicomico River Head, were so categorized.

Indicator Use

Because benthic community indicators are influenced by point and nonpoint sources of pollution as well as physical habitat condition, a variety of interventions can be looked at to improve benthic community health. The heavy contribution of landscape modification and land management practices to nonpoint source pollution as well as to physical habitat degradation suggests that addressing land use and forestry and agricultural processes will have the most important role to play in improving conditions for the non-tidal benthic community.

Non-tidal Benthic Index of Biotic Integrity (IBI)



Prepared by: Maryland Department of Natural Resources - 1999

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Percent of Headwater Streams in Core Forest

The Indicator

Headwater streams have been defined as first-order streams (having no tributaries) identified by the Maryland Office of Planning (OP). In many cases the OP stream data missed true first order streams, so this parameter may include second-order streams. Core forest has been defined as “interior” forest or forest greater than 300 feet from differing land cover or primary, secondary, or county roads (i.e., roads considered large enough to break the canopy). Forest cover is defined as deciduous, coniferous or mixed forest land cover types from EPA Region III’s land cover data set (MRLC). The land cover data set was developed using satellite imagery dated from 1991-1993. The total length of first order stream segments within interior forest was summed by watershed. This was divided by the total length of first order streams in the watershed.

Forested headwater areas represent pristine, sensitive communities with high value for conservation. They benefit both terrestrial and aquatic ecosystems. They provide water and food for terrestrial animals, and provide microhabitat conditions for riparian vegetation, favoring some rare species (Forman, 1995). Forested headwater streams also provide the base of the aquatic food web. Shaded streams often have a higher algae diversity than unshaded streams.

Trees and other vegetation are a source of detritus, which is colonized by bacteria, fungi, and epiphytic algae communities, and consumed by insect larvae, crustaceans, and other aquatic invertebrates. Detritus is swept downstream, where it is further processed. Overhanging trees also provide shade to shelter fish, and create snags when their twigs and branches fall into the stream. In addition, insects which drop into the stream provide an important food source for fish, in some cases forming their staple diet. Core forests potentially provide important and unique co-occurrence of habitat types.

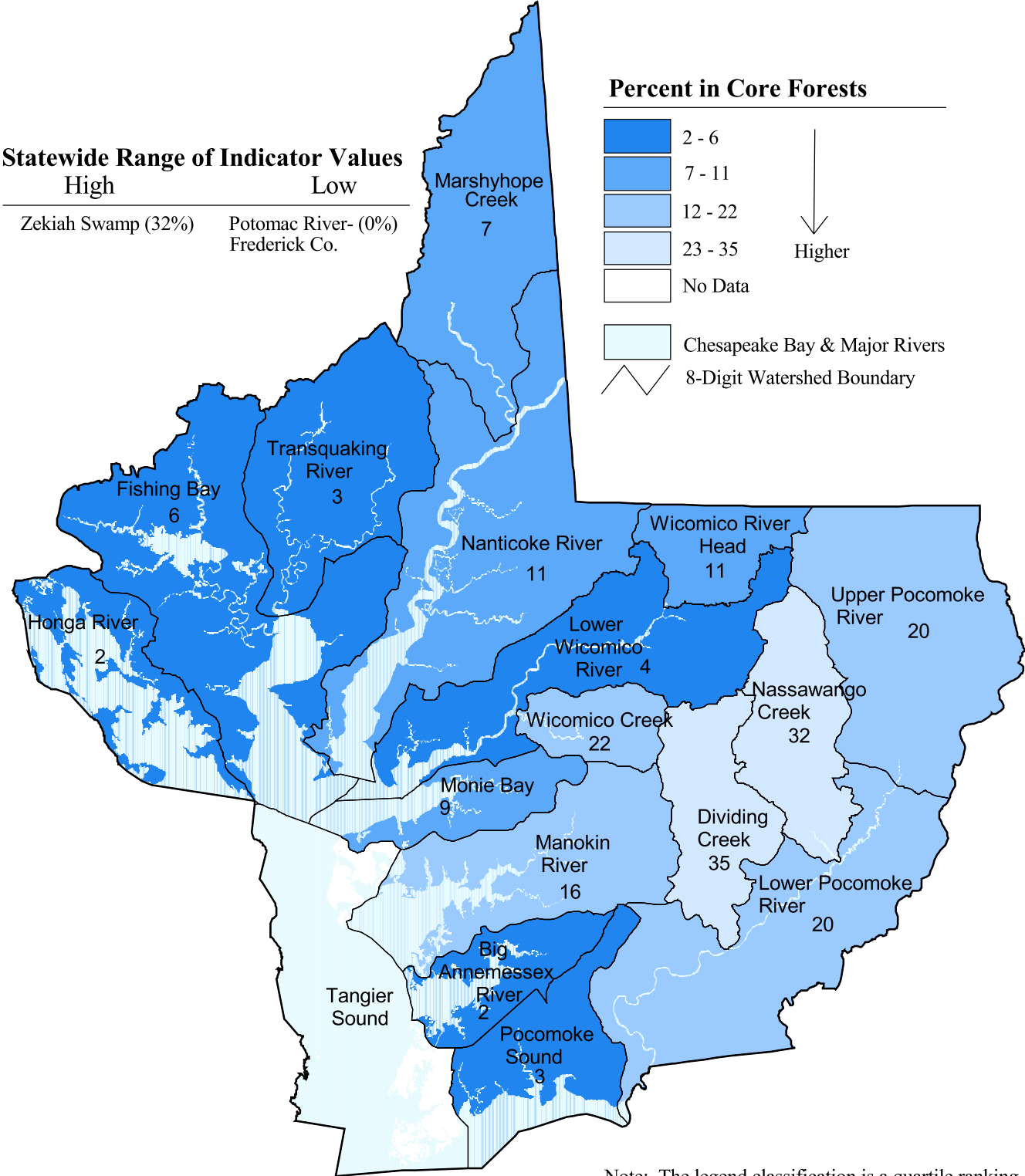
Interpretation

Not surprisingly, headwater streams in core forests are highly correlated with the distribution of interior forest. In the Lower Eastern Shore basin, they are more likely to be found in the Pocomoke watersheds, with Dividing Creek and Nassawango Creek watersheds showing the largest percentages.

Indicator Use

This indicator can be used in conjunction with other forest indicators to identify which interior forest areas are most likely to provide multiple terrestrial and aquatic ecosystem benefits. As such, it provides a further refinement for targeting land or forest conservation activities beyond stream order or interior forest considerations separately.

Percent of Headwater Streams in Core Forest



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Summary of Aquatic System Indicator Values

Although every watershed in the Lower Eastern Shore Tributary Basin is considered among the lowest-rated 25% of watersheds for at least one indicator, the data are very scattered, as shown in Table 4. Some indicator data are lacking altogether for several watersheds, especially those that do not contain an estuarine component. Since none of the watersheds with Submerged Aquatic Vegetation (SAV) data had more than 10% coverage, this indicator does not help to differentiate watersheds. The Lower Wicomico, Lower Pocomoke, and Transquaking Rivers and Pocomoke Sound were rated lowest overall, although none was so rated on more than half the remaining indicators.

Table 4
Watersheds and Aquatic System Indicators

Watershed Name	Water Quality	Water Quality	SAV Habitat	SAV	Migratory Fish
	- Habitat	- Eutrophication		Abundance (%)	Spawning Index
Pocomoke Sound	8.00	4.33	8.0	10	1
Lower Wicomico River	6.00	4.67	2.5	10	5
Transquaking River					3
Lower Pocomoke River	6.00	6.67	2.5	10	4
Upper Pocomoke River					0
Monie Bay			2.5	10	1
Big Annemessex River	8.67	6.67	4.0	10	1
Manokin River	7.00	4.33	5.0	10	2
Tangier Sound	7.67	6.17	8.0	10	0
Wicomico River Head					0
Nassawango Creek					0
Wicomico Creek					4
Nanticoke River	6.50	4.67	3.0	10	6
Marshyhope Creek					6
Fishing Bay	7.67	4.67	8.0	10	3
Dividing Creek					0
Honga River					1

continuing

Watershed Name	% Unforested Riparian Buffer	Instream Habitat	Non-Tidal Benthic IBI	% Headwaters in Interior Forest	Number of Times in Lowest-Rated 25%
Pocomoke Sound	14	3.00		3	4
Lower Wicomico River	21	2.76		4	4
Transquaking River	37	3.36	2.93	3	3
Lower Pocomoke River	23	5.50	3.62	20	3
Upper Pocomoke River	38	4.80	4.67	20	2
Monie Bay	10			9	2
Big Annemessex River	28			2	2
Manokin River	31	4.57	4.45	16	2
Tangier Sound	2				2
Wicomico River Head	35	5.83		11	2
Nassawango Creek	24	5.36	3.80	32	1
Wicomico Creek	31	2.86		22	1
Nanticoke River	21	4.91		11	1
Marshyhope Creek	46	5.27	5.71	7	1
Fishing Bay	8			6	1
Dividing Creek	24			35	1
Honga River	5			2	1



Terrestrial System Degradation and Fragmentation

As urban development, road building and, to a lesser extent in recent years, expansion of agriculture and mineral extraction have converted more and more land to intensive human use, upland terrestrial habitats have been lost or fragmented. Although the concern is usually associated with loss and fragmentation of forest, grassland loss is also considered here. Many bird and other wildlife species require large blocks of forest for successful breeding, or some life stage of particular species requires the specialized type of habitat more likely to be found in a large natural area than in a small patch. Protecting large patches of natural landscape and connecting them with green corridors can help to maintain the viability of populations otherwise rendered vulnerable because of small numbers and/or isolation. This is the basis for the Department of Natural Resources' Green Infrastructure initiative and is the concept that lay behind the original efforts to protect greenways.

There is an economic dimension to the loss and splitting up of resource lands also. The viability of both agriculture and forestry depends on the availability not just of suitable land but of large, uninterrupted tracts. Failure to protect substantial amounts of land from intensive development also increases the potential threat to maintaining biological diversity and the resource base needed to support natural resource-based recreation. Increasing demands placed on existing public land resources for recreation can be detrimental to the maintenance of ecological functions at sites already acquired, while acquiring more natural area to meet the expanded need becomes more and more difficult—increased real estate values resulting from development pressure translate to less open space protected for each dollar spent.

Wetlands are a special system with, clearly, a strong tie to aquatic systems, particularly for those wetlands in the riparian zone. Some of the wetlands most susceptible to damage or destruction are those non-tidal wetlands which do not appear wet much of the time. For this reason, and because they support terrestrial fauna, we include wetlands here as part of the terrestrial system, recognizing their hydrologic connections to the aquatic systems considered elsewhere.

Stressors and Sources

Although natural processes like sea level rise and coastal shoreline erosion contribute to the loss of wetlands, the primary stressors of natural terrestrial systems are largely human-induced. Human population growth, exacerbated by decreasing household sizes, continuing trends toward larger lot sizes, and out-migration from existing communities, has spurred the rapid conversion of natural areas to residential, commercial, and industrial uses. The actual loss of natural resource lands to intense human use is not the only problem here; the increasing fragmentation of the natural area that remains, into smaller and smaller patches, significantly stresses the maintenance of ecosystem health and the viability of important species.

Low density, *sprawl*, development, characteristic of much of what has occurred in recent years, is a stressor of aquatic systems as well as terrestrial: it is a major contributor of nutrients to local waterways. Research has revealed that low density development (1 unit per 5 acres) contributes nearly 17 times more phosphorus and 24 times more nitrogen per dwelling unit than high density development. Septic systems are the predominant form of sewage treatment in low density areas. Newer system designs, which allow for nutrient removal, are expensive and rarely utilized,

although recently proposed legislation would require their installation in particularly sensitive areas. Finally, low density development also requires the increased use of automobiles, which consume gasoline and contribute nitrogen oxides to the air that are subsequently deposited into waterways.



Lower Eastern Shore Issues

The Lower Eastern Shore Action Strategy Steering Committee identified a few specific issues related to terrestrial systems:

- Forests, from a variety of perspectives: their fragmentation by conversion to developed uses, the opportunities for public/private management cooperation for water quality, habitat and recreational purposes, and maintenance of forestry as an economic sector of importance to the region, with possible needs for incentives similar to those for agriculture.
- Wetland restoration efforts and their impact on local land use planning.
- Management of State lands, both resource protection activities and over-use problems or potential.

Management Programs

Actions that most significantly affect terrestrial systems are taken daily by private individuals and organizations and by local governments. These actions involve buying and selling and using

land for the owners' particular and sometimes narrowly-focused purposes. Local government planning and land use programs attempt to guide or structure these decisions in such a way as to conform to local goals, among which are protection of important environmental values.

Although the State's Critical Area Program, discussed in earlier sections, has a significant impact on land use, only one State regulatory program dealing explicitly with terrestrial ecosystem issues has been identified:

- ***The Forest Conservation Act*** (DNR) is a regulatory program designed to retain forest cover as much as possible during the land development process. It requires the identification of existing forest stands on a property and protection of the most desirable stands. It also calls for establishing forest on other areas on the site or payment of a fee for reforestation off-site.

The majority of State incentive programs identified deal primarily with forests, with a lesser emphasis on other aspects of terrestrial systems, including the human components of these systems.

- ***The Forest Conservation and Management Program*** (DNR) provides participating landowners with a tax incentive by freezing assessments, usually at the agricultural rate. Landowners with five or more acres enter into an agreement to adhere to a forest stewardship plan for a minimum of 15 years. They may increase their acreage by planting trees.
- ***The Wildlife Habitat Incentives Program*** (NRCS) provides for cost-sharing with private landowners (up to 75% from NRCS) to plan and implement practices to improve wildlife habitat. Agreements cover a five to ten year period and provide for NRCS technical as well as monetary assistance.
- ***The Forest Stewardship Program*** (DNR) provides technical assistance, for a small fee, to owners of five or more acres of existing or potential forest land to help enhance the natural resources values of their properties.
- ***The Stewardship Incentive Program*** (DNR) provides cost share up to \$10,000 to a landowner to implement stewardship plans that will be maintained for at least ten years. This program was not funded in 1999.
- ***Woodland Incentive Program*** (DNR) provides cost-share assistance to private - owners of ten to 500 acres of woodland for tree planting, including riparian forest buffer establishment. Approved practices including planting, seeding, timber stand improvement, burning and site preparation; they must be followed for up to 15 years.
- ***The Integrated Natural Resources Assessment*** (INRA) (DNR) framework can be used to refine the identification of the State's "green infrastructure" and to integrate it with local and statewide Greenways planning and implementation.
- ***The Rural Legacy Program*** (DNR) helps to assure protection of important agricultural and associated natural resource areas. Implementing the program,

- through funding and award of grants for both easement and fee estate purchases, is under way in 14 designated areas, and additional area selection is under way.
- ***Smart Growth*** (multiple agencies) is the Governor's initiative designed to promote more compact development in locally designated growth areas, usually in or contiguous to existing communities.

One private program, applicable only on the Eastern Shore, is sponsored by Chesapeake Wildlife Heritage:

- ***The Waterfowl Festival Sanctuary Program*** compensates farmers who leave unharvested corn or soy beans and plant a winter cover crop to provide safe feeding and resting areas for Canada geese.

Program Issues and Observations

- ✓ Fragmentation of terrestrial ecosystems is not really addressed by the several existing programs designed to encourage retention or expansion of forests or wetlands. Until concepts like the Green Infrastructure gain recognition and acceptance as part of local and regional planning, and plan implementation, the approach to habitat protection will remain piecemeal.
- ✓ Incentive payments for establishing conservation practices in lieu of other uses of land, particularly agricultural land, have not been sufficiently high to encourage their widespread use in the Lower Eastern Shore.
- ✓ Regulation of land activities, particularly for the sake of terrestrial resources as opposed to impacts on water quality, has lagged behind regulation of activities affecting water and air.
- ✓ Centralized record-keeping for the many projects and programs in place in a County would be most helpful to County officials.
- ✓ The Stewardship Incentive Program was cited as being an excellent program to work with. Unfortunately, Congress eliminated funding last year.

The Indicators

Terrestrial system indicators—those dealing with forest, grassland, most wetland environments, and the flora and fauna associated with them—are less well-developed than those for aquatic systems. Public attention has long been focused on aquatic systems, at least to some extent because of the early emphasis of much of the environmental movement on water pollution. Concern for terrestrial resources has grown along with the increasing attention being devoted to

land-based sources of water quality problems. What is happening to terrestrial ecosystems in their own right is an even more recent focus of interest; fewer data exist from which to construct indicators. Thus a number of the indicators which follow focus on human encroachments into natural areas, and the continuing stress of population and development on the natural resource base, and on activities undertaken to reduce this pressure, like protecting natural resource and agricultural lands through public purchase or the acquisition of easements.

- Percent of watershed in forest
- Percent interior forest
- Forest patch size
- Forest edge density
- Percentage of watershed in unmodified wetlands
- Road density
- Population density
- Land protected for natural resources



Percent of Watershed Forested

The Indicator

Forests provide a wide variety of benefits to the citizens and other living resources of Maryland. Forested ecosystems provide water quality protection, aquifer recharge, soil protection and replenishment, carbon dioxide absorption, and wildlife habitat. Socioeconomic benefits include those that result directly from forest products industries and recreational opportunities like hiking, hunting, fishing and camping, as well as enhanced property values and more “livable” communities.

Stresses or threats to the forested land base are attributable to both natural and human-induced landscape impacts. Much of the threat now facing the state’s forests is associated with potential conversions to non-forest land uses, particularly urban uses.

This indicator looks at the abundance of forests within Lower Eastern Shore watersheds. It is defined as the percent of the total land area of a watershed that is in deciduous, coniferous or mixed forest land cover types as defined by EPA Region III land cover data (MRLC).

Interpretation

The watersheds of the Pocomoke River basin contain the largest assemblages of forest land in the Lower Eastern Shore Tributary Basin as well as the Eastern Shore of Maryland as a whole. These forest lands, which are located on public and private lands throughout the basin, are important economic resources to the region, as the forest products industry is the second largest on Maryland’s Eastern Shore. Ecologically, the Lower Eastern Shore Tributary Basin’s forests harbor habitat for a number of important wildlife species (including Delmarva Fox Squirrel and a variety of forest interior nesting species) as well as providing water quality benefits critical for Maryland’s Chesapeake Bay restoration effort.

Indicator Use

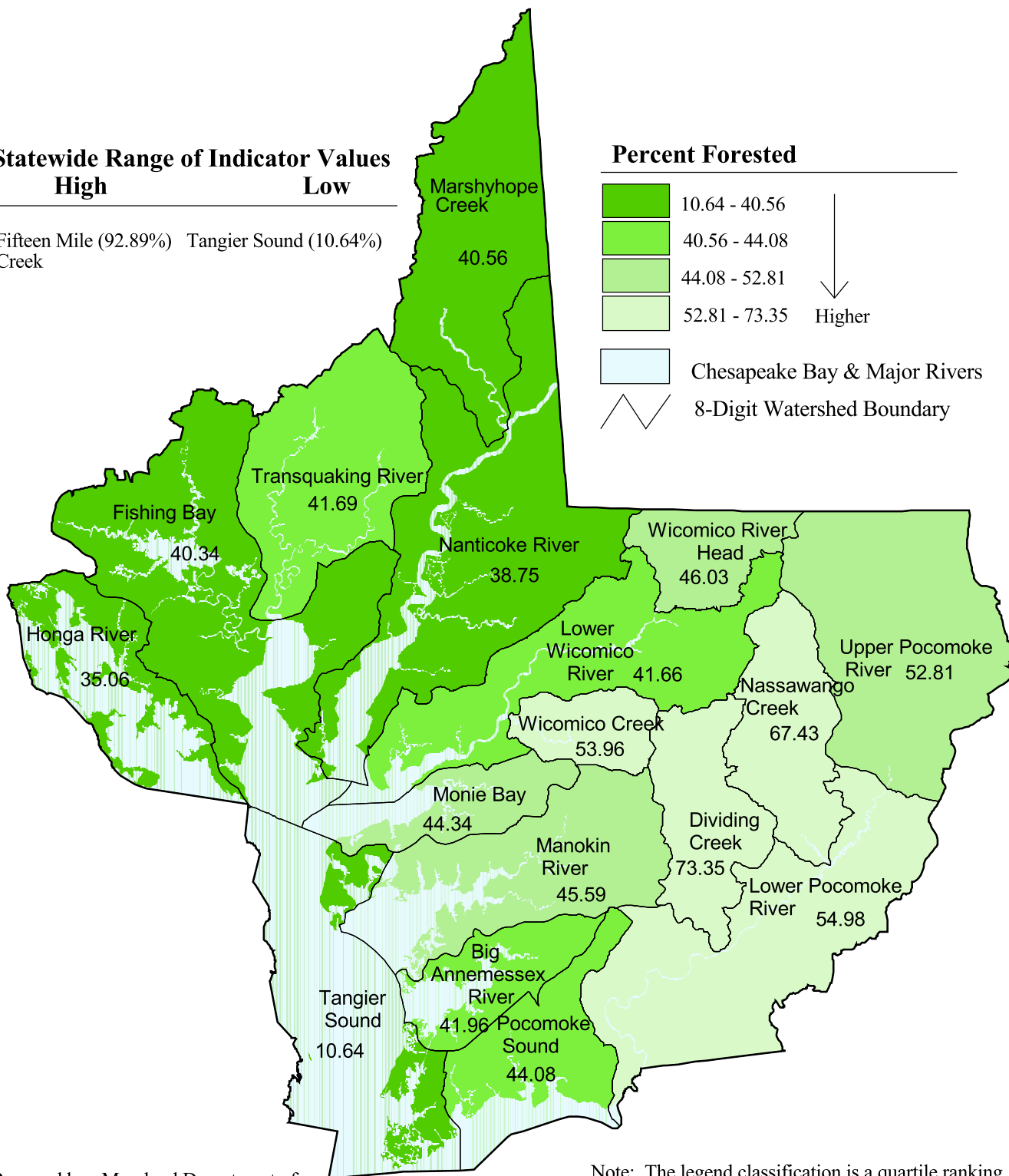
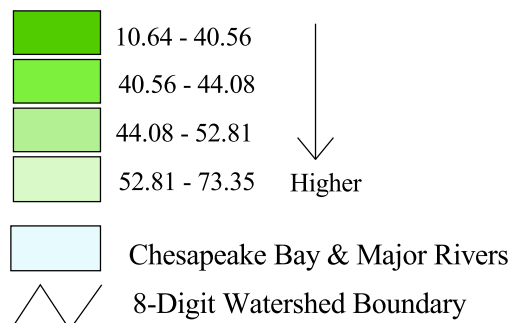
This indicator provides a regional view of which watersheds are important to conserve to support the basin’s forest products industries. These same watersheds are important ecologically in that they contain some of the highest concentrations of forest land on the entire Delmarva peninsula. Watersheds with lower values for the percent forest indicator may be appropriate candidates for reforestation efforts, particularly where such efforts are targeted to achieve multiple ecological benefits.

Percent of Watershed Forested

Statewide Range of Indicator Values

High	Low
Fifteen Mile Creek (92.89%)	Tangier Sound (10.64%)

Percent Forested



Prepared by: Maryland Department of Natural Resources - 1999

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Percent Interior Forest

The Indicator

Interior forest is preferred by particular plant and animal species that require a type of habitat isolated from other, non-forest areas. Forest and non-forest land cover were defined from EPA Region III (MRLC) land cover and State Highway Administration roads data. Interior forest was defined as forested land cover at least 300 feet from differing land cover or from primary, secondary, or county roads (i.e., roads considered large enough to break the canopy). Percent area equals the area of interior forest in the watershed, divided by the total land area within the watershed.

Many species are officially listed as rare, threatened, and endangered because of habitat loss. Cutting of old growth forests and development are probably the primary factors responsible for the imperiled status of the Delmarva fox squirrel (Pennsylvania Department of Conservation and Natural Resources, 1998). The northern goshawk, a state endangered species, nests in mature and old tree habitat. Bushman and Therres (1988) list 19 birds that breed in coastal Maryland which require large blocks of interior forest.

Interpretation

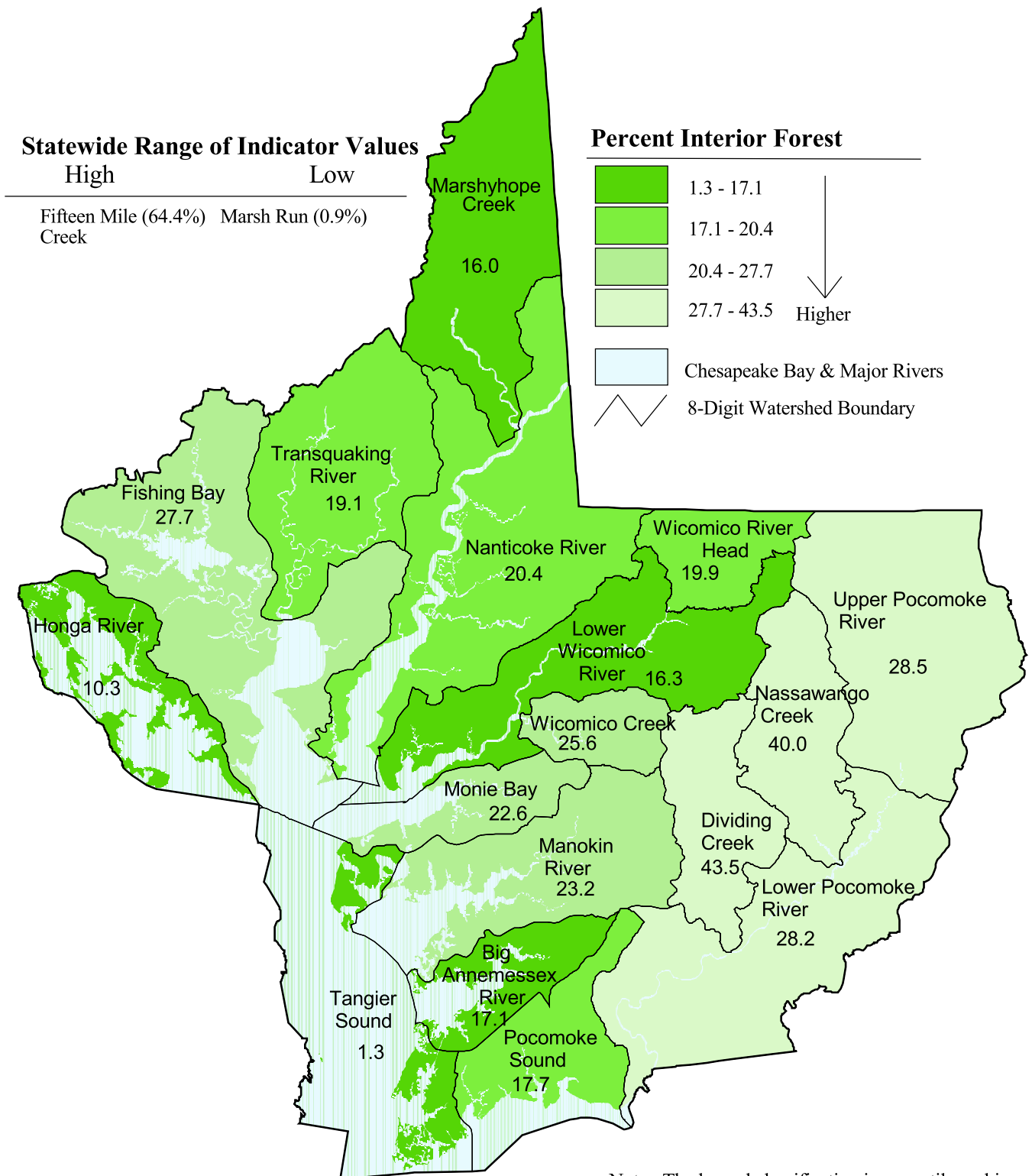
In the Lower Eastern Shore Tributary Basin, large blocks of forest that contain interior conditions are most likely to be found along the Pocomoke River and its tributaries. In particular, the Nassawango Creek and Dividing Creek watersheds have some of the highest concentrations of interior forest on the Eastern Shore of Maryland. Interior forest habitat conditions are also likely to occur within areas of the Fishing Bay watershed, including Blackwater National Wildlife Refuge.

Within the Lower Pocomoke and Dividing Creek watersheds, much of the potential interior forest habitat is in public ownership as part of Pocomoke State Forest. In other watersheds these resources are predominantly privately owned.

Indicator Use

Interior forest habitats are relatively rare and easily lost (Jones et al 1997). Percent interior forest provides one measure for identifying important habitat areas for specific species dependant upon interior conditions. As such, it can help in the identification of forest habitat conservation opportunities on a regional scale. It also suggests to local decision-makers that special care be taken in the land development process to avoid breaking up interior forest areas.

Percent Interior Forest



Prepared by: Maryland Department of
Natural Resources - 1999

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Average Forest Patch Size

The Indicator

The fragmentation of Maryland's forests is having an adverse effect on many of Maryland's wildlife species (DNR, 1998). As residential and other development spreads across the landscape, the spatial configuration of the remaining forests changes, and in most cases the tendency is towards smaller and more isolated forested tracts, or "patches." This in turn impacts habitat available to species dependent upon larger forested tracts and the "interior" conditions these tracts often contain. This indicator looks at the mean size of forest patches within a watershed as defined by EPA Region III (MRLC) land cover, expressed in acres).

As forest patch size decreases, and as patches of habitat become more isolated, population sizes of species dependant upon contiguous blocks of forest, especially of rare species, may decrease below the threshold needed to maintain genetic variance, withstand oscillations and meet social requirements like breeding and migration.

In addition, to some extent the sustainability of the forest resource land base is linked to the size of forested patches and tracts. For example, private forestry activities (both industrial and non-industrial) are more likely to be commercially viable in regions with an intact, relatively unfragmented resource base.

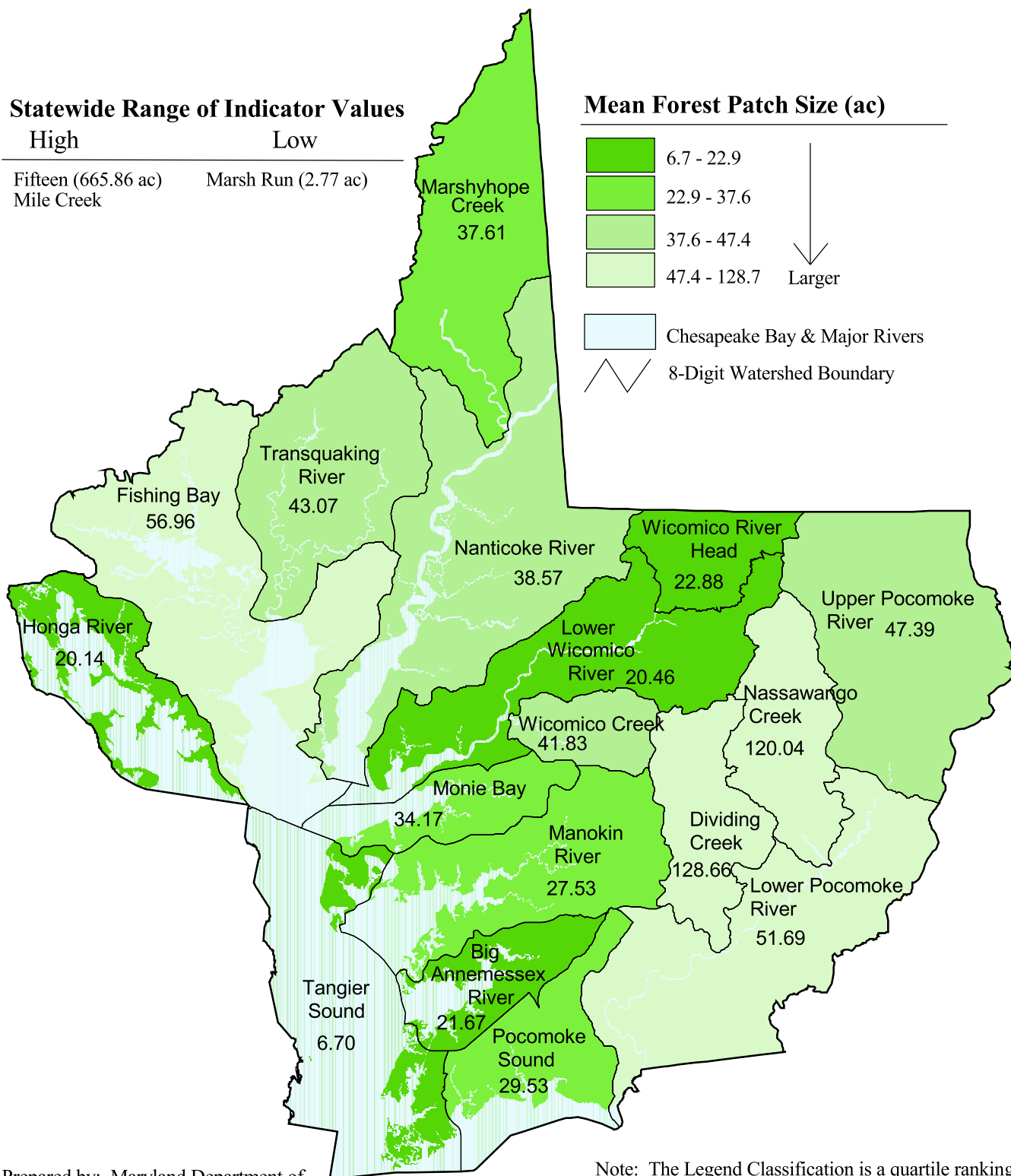
Interpretation

In general, watersheds of the Pocomoke river contain larger forest patches, many of which extend across watershed boundaries. As would be expected, the Nassawango and Dividing Creek watersheds, which also score high for interior forest, contain by far the largest forest patches in the Lower Eastern Shore Tributary Basin. In addition, the Fishing Bay watershed, which also contains extensive wetlands, contains large patches of forest in the vicinity of Blackwater National Wildlife Refuge, Island Creek and along the western boundary of the watershed.

Indicator Use

Watersheds with large forest patches should be the focus of land conservation initiatives aimed at maintaining the integrity of these patches, and protecting the connectivity of forest resources in the region. For those watersheds with smaller forest patches, opportunities may exist to increase habitat and habitat connectivity by examining gaps in forest cover within existing patches, as well as expanding forest cover along the external edges of existing patches. This indicator provides a first cut approximation to identify which watersheds may be more suitable for forest conservation as opposed to restoration initiatives.

Average Forest Patch Size



Prepared by: Maryland Department of
Natural Resources

Note: The Legend Classification is a quartile ranking
of watershed within the Lower Eastern
Shore Tributary Basin

December 1999

Forest Edge Density

The Indicator

A forest edge is the outer band of a forest patch, an area that may vary in width depending on the parameters considered. In this study, forest edge has been calculated as a band roughly 300 feet wide. It is influenced by surrounding environmental conditions and is thereby different from the forest interior (Forman and Godron 1986). Forest edges have significant gradients of solar radiation, temperature, wind speed, and moisture between the forest interior and the adjacent land. If the adjacent land is developed in residential, commercial or industrial uses. (Forman and Godron 1986; Brown et al 1990) edge effects can also include noise, artificial light, exotic species, human disturbance and predation by cats and dogs. Generally speaking, edge can be considered a measure of forest fragmentation, the breaking up of large forests into smaller and smaller pieces. Forest edge density was calculated as the total length of forest edge in a watershed, divided by the land area of the watershed. Land cover is based on EPA Region III (MRLC) land cover data.

Interpretation

Depending upon perspective, edge may or may not be desirable. It can promote overall biological diversity at the local scale by providing habitat for species dependant upon two or more land cover types (Jones et al 1997), but the creation of edge conditions often occurs at the expense of interior conditions, which are now far more rare. Thus, overall biodiversity may be reduced on large scales. Finally, some edge-dependant species of both plants and animals have come to dominate, and in some cases have parasitized, native species that are dependant upon larger, unbroken forest patches.

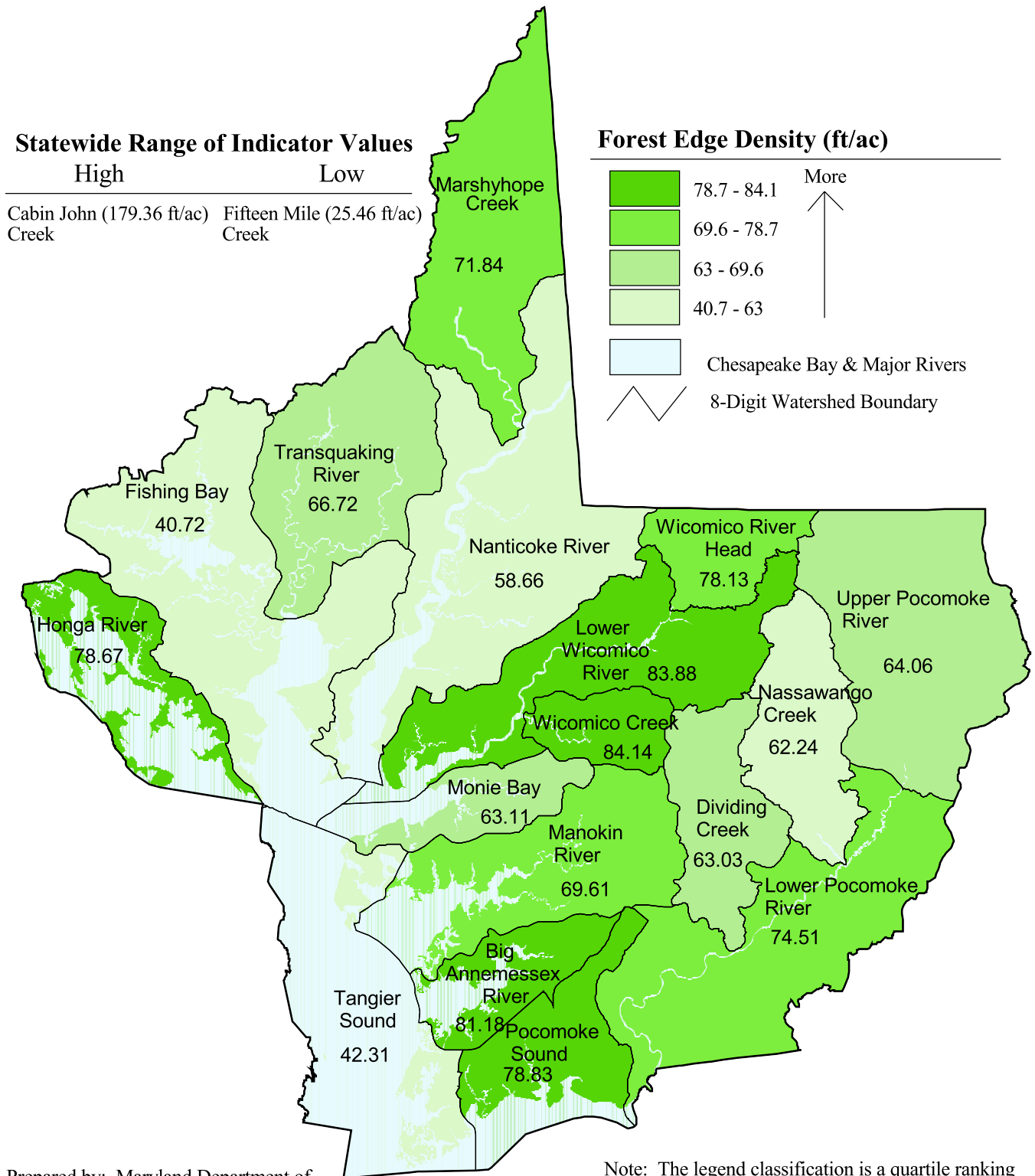
Forest edge habitat conditions tend to be more expansive in those watersheds that (1) contain a significant amount of forest and (2) have smaller mean patch sizes (thereby reducing the amount of interior forest habitat present).

Although forest edge habitat is common throughout the Lower Eastern Shore Tributary Basin, watersheds where edge habitat conditions are most prevalent include the Lower Wicomico River, Wicomico Creek, Big Annemessex and Pocomoke Sound.

Indicator Use

Since different species ultimately have different habitat requirements, edge density as depicted here should be used with caution. For some species 300 feet may represent a reasonable distance to approximate edge habitat conditions. For other species this distance may be substantially smaller (or larger). Nonetheless, edge density can provide an overall snapshot of forest fragmentation on a regional scale.

Forest Edge Density



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Percent of Unmodified Wetlands

The Indicator

Wetlands, lands which are saturated with water for significant periods during the year, provide a variety of services to the environment. Among these are the retention of water from periods of precipitation and its gradual release into streams as base flow, reduction of flood volumes, trapping of soil particles, and provision of habitat for specialized species. Saturated soils create conditions of low oxygen, promoting chemical actions that help retain organic material and nutrients, removing them from the water. Modifications to wetlands—cutting trees or removing other vegetation, draining or intercepting sources of water—interfere with or eliminate the ability of the wetland to perform these environmental functions. Unmodified wetlands are therefore desirable and indicative of a healthier environment.

The National Wetland Inventory (NWI), a cooperative effort between the U.S. Department of the Interior's Fish & Wildlife Service and the Maryland Department of Natural Resources, classified the wetlands in Maryland in 1995. The classification system is comprehensive, covering everything from tidal marshes to farm ponds. (For this indicator, open water was not included as an unmodified wetland.) In addition, any wetlands with the special modifier in their NWI classification of “excavated,” “diked or impounded”, or “partially drained or ditched” were excluded in calculating the percentage of the watershed in unmodified wetland. Ditching or draining is a common impact to wetlands in both agricultural and residential areas. Drained wetland soils increase the exposure of the organic material in the soil to oxygen, causing a gradual loss of organic matter.

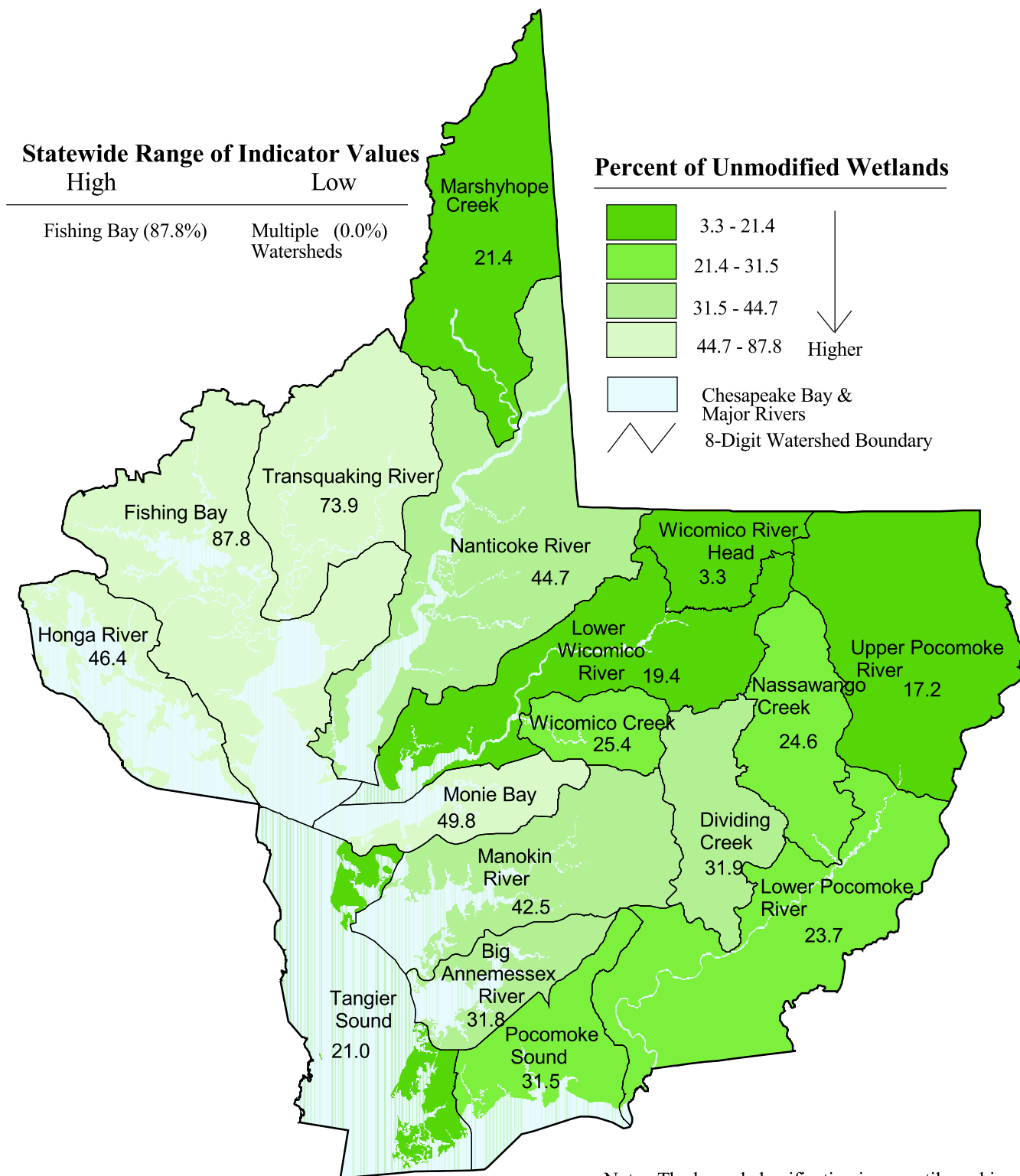
Interpretation

The Lower Eastern Shore Tributary Basin is an area of unconsolidated (non rock) soils with little change in elevation close to sea level. Much of the river system is tidal, and tidal marsh wetlands are extensive. The majority of the wetland acreage in the state is in this region. The marshes in this area contribute substantially to the productivity of the Chesapeake Bay. Monie Bay, (site of a National Estuarine Research Reserve), the Honga, Nanticoke, and Transquaking Rivers contain exceptional marshes of national significance.

Indicator Use

Areas with high percentages of unmodified wetlands are providing major ecological services to the Chesapeake Bay as a whole. If we are to continue to receive these services, the wetlands need protection from the types of hydrologic modification which have occurred in much of the watershed to date.

Percent of Unmodified Wetlands



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Road Density

The Indicator

Road density, a stressor indicator, is defined as the linear feet of roads per watershed area (acres). It was derived by calculating the total distance of roads using Maryland Office of Planning (OP) road files. Roads include interstate, state primary, state secondary, and connector roads.

Roads can be significant barriers to wildlife movement, seed propagation, water flow, and other ecological processes. The movement, both successful and unsuccessful, of animals along or across roads depends on the width of the roadway, vehicle traffic, and the mobility and behavior of the species. Narrow unpaved roads with few vehicles are often used at night by predators. However, paved roads strongly affect animal movement, from invertebrates to large mammals. Large mammals cross most roads, but the rate of crossing is typically lower than movement in more favorable habitat. Amphibians and turtles exhibit reduced movement across roads. Some nesting birds and large mammals avoid the vicinity of roads altogether. Road kills are a major population sink for terrestrial animals.

Other potential deleterious effects of roads include soil and water pollution, erosion, sedimentation of waterways and fish declines, and edge effects, among others (Noss and Cooperrider 1994). Finally, they can also be an indicator of where additional development can be expected, based on the fact that some degree of infrastructure/access already exists.

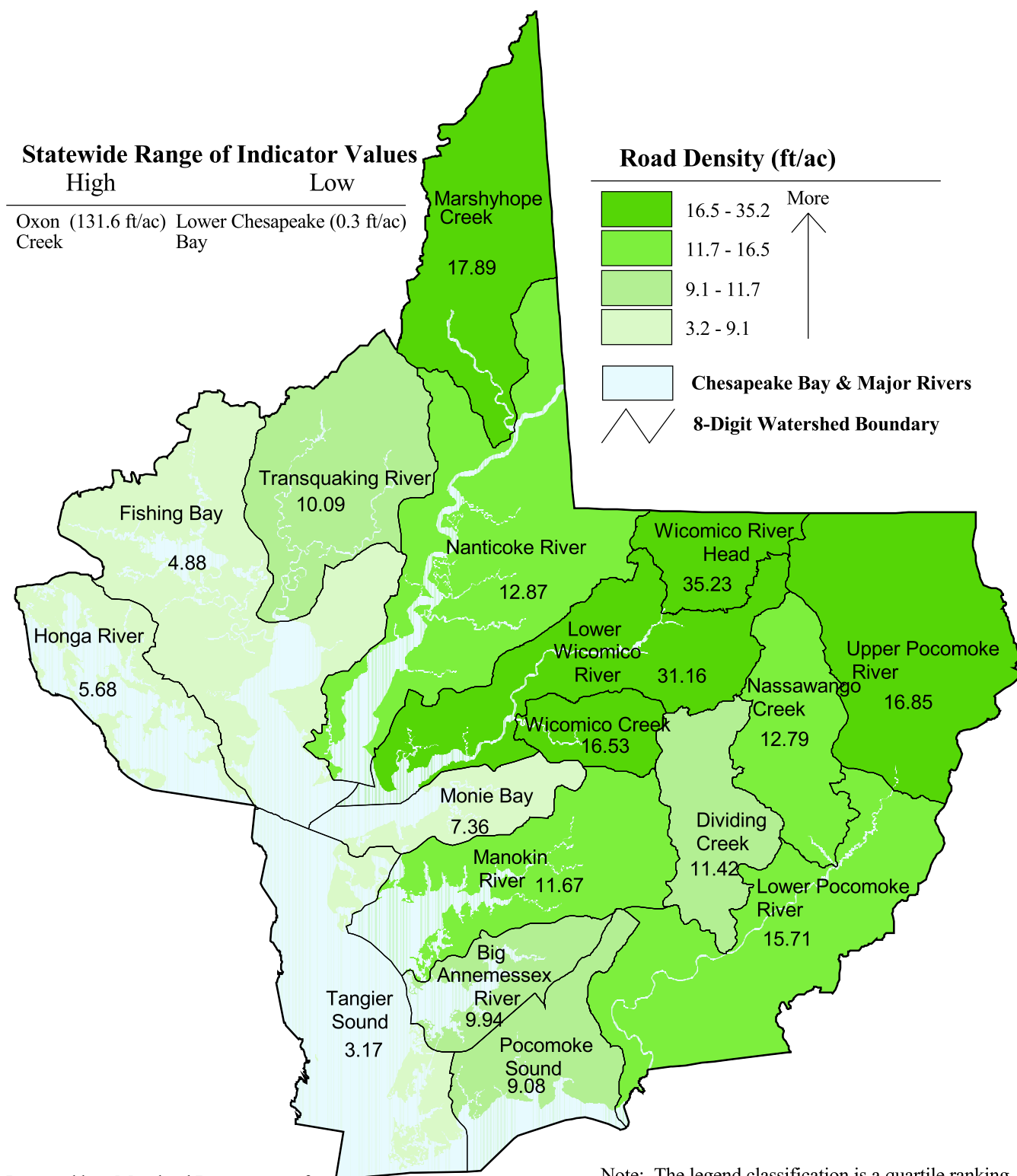
Interpretation

Relative to other tributary basins, the Lower Eastern Shore is characterized by low road density. Road density is highest in the watersheds containing Salisbury and its suburban development (Lower Wicomico River and Wicomico River Headwaters). Watersheds in the west and southwest parts of the tributary basin have some of the lowest road densities in the State.

Indicator Use

Road density is one measure for identifying areas subject to hydrologic modification, and therefore where restoration efforts or retrofitting might be targeted. Conversely, it provides an indirect measure of terrestrial and aquatic habitat fragmentation and therefore may provide insight as to how effective land conservation activities may be relative to habitat requirements. Land conservation opportunities may be easier to identify in watersheds with low road densities and may ultimately be more effective within these watersheds for protecting a variety of ecological functions.

Road Density



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Population Density

The Indicator

Population density provides a way of measuring the impact of people on the natural environment—it is thus a stressor indicator. Population density, calculated as persons per acre within each watershed, was derived from the 1990 U.S. Census of Population, allocated to the Maryland Department of Environment's designated second level, or eight-digit, watersheds. Population Density was derived by dividing total number of estimated persons living within a watershed by the total acreage of land contained within that watershed.

In conjunction with information about lands protected for natural resources uses, including parks and commercial forests, population density helps to define the degree of fragmentation of natural ecosystems, particularly forests, into smaller and less sustainable pieces. In conjunction with information on impervious surfaces and numbers of septic tanks, density helps to define the potential severity of human population impacts on water quality and the hydrology of a watershed.

Interpretation

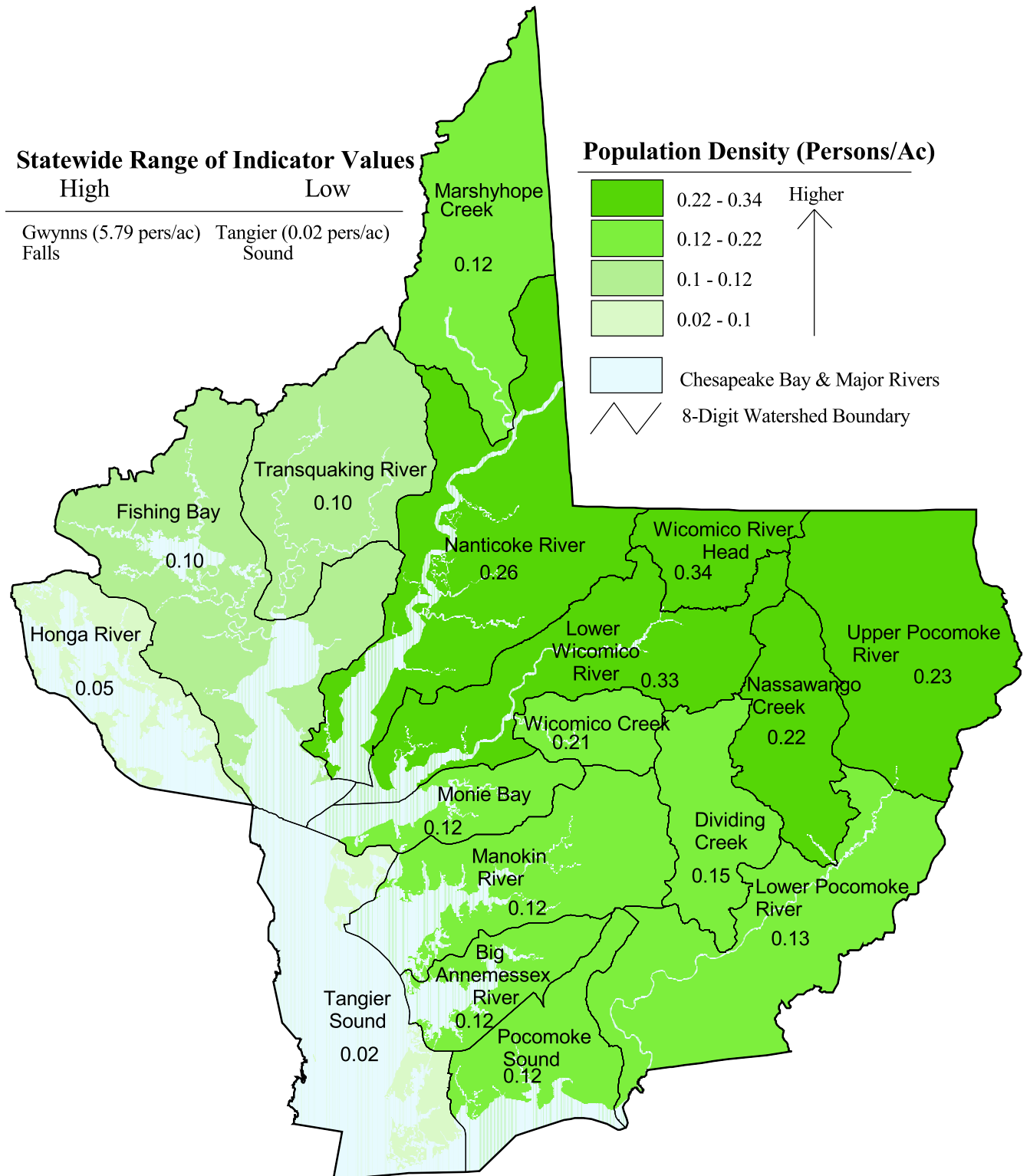
Population density varies statewide from a low of less than one person per acre in rural areas to much higher numbers in highly urbanized areas. There is a strong relationship between protection of natural landscapes and population density—as population becomes more dense, more and more land is used for transportation and commercial, institutional and industrial uses as well as housing. Denser populations both support and require community services such as public water and sewer, with their attendant implications for both surface and ground water quantity and quality.

The presence of only one significant urban area, Salisbury, in the Lower Eastern Shore Basin is reflected in the highest mapped density being found in the Wicomico River watersheds. Even here, the density is far lower than in other urbanized watersheds in the State. The predominance of marshes in the Honga River and Tangier Sound watersheds largely accounts for these watersheds' having the lowest population densities in the State.

Indicator Use

Population Density is a significant indicator in analyzing the impact of growth and development upon the land, upon natural resources and upon society in terms of required infrastructure. Under planning policy initiatives such as Smart Growth, areas of higher population density suggest where public policy initiatives might most likely direct future growth. At finer scales than those depicted in these indicator maps, population density suggests where public water and sewer systems might be most feasible.

Population Density



Prepared by: Maryland Department of
Natural Resources

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Land Protected for Natural Resource Conservation

The Indicator

This indicator includes State Forest lands, State Parks, Wildlife Management Areas and Heritage Areas held by the Department of Natural Resources; federal properties like the Blackwater National Wildlife Refuge; and holdings of The Nature Conservancy, Chesapeake Bay Foundation, Maryland Ornithological Society and similar groups. It also includes more than 4400 acres of privately-owned lands under conservation easements held by the Maryland Environmental Trust. *Caveat: the data used to create this map date from about 1994 and do not reflect more recent actions such as major acquisitions by The Nature Conservancy in the Nassawango Creek watershed and the State's recent acquisition of some 58,000 acres of land from Chesapeake Forest Products Corporation, located throughout the Lower Eastern Shore.*

Interpretation

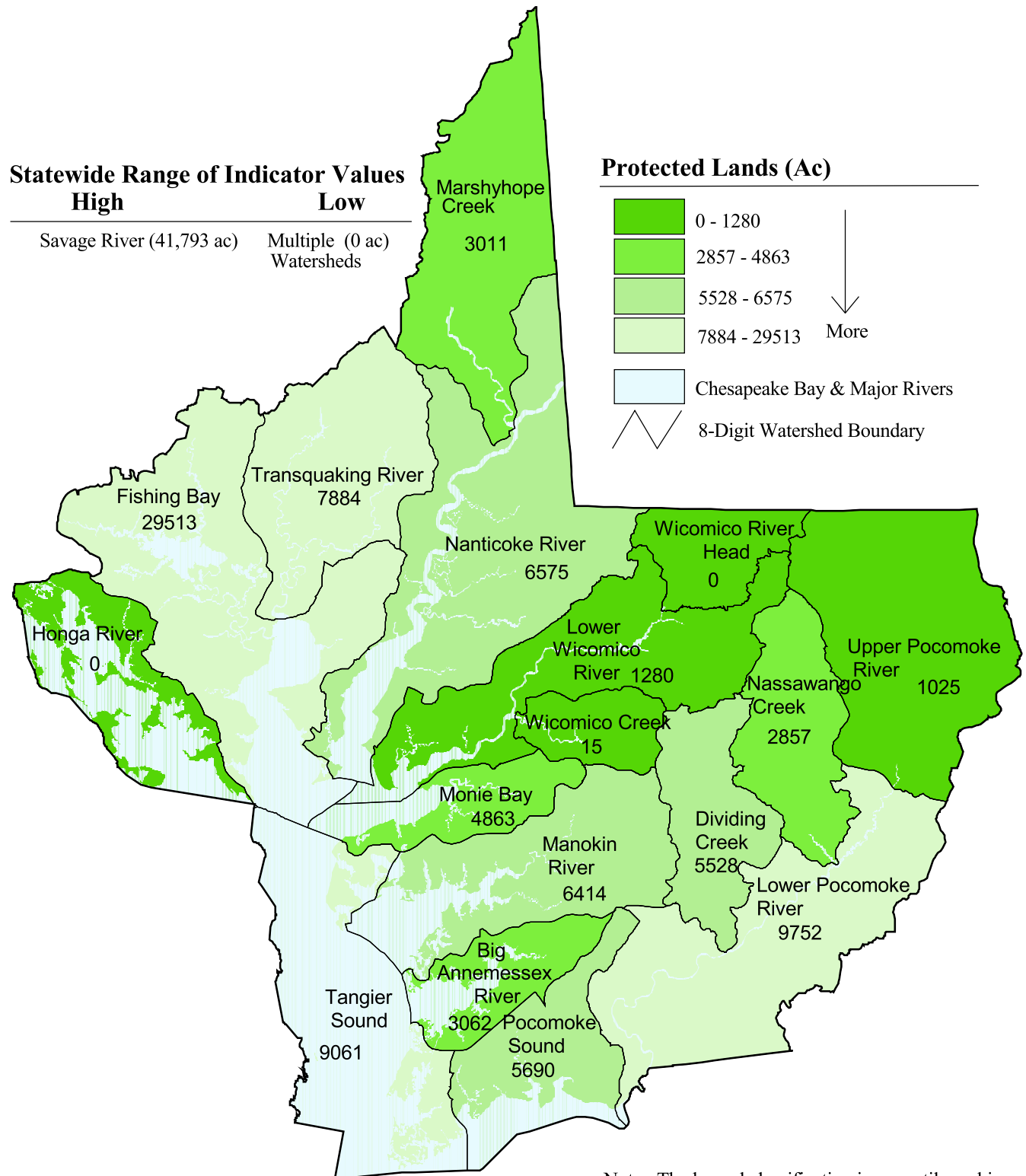
This indicator reflects, for the most part, the public and private intent to hold land for its conservation values, as distinguished from its economic potential. Included in the holdings of the State and Federal governments, and private organizations, are some of the most significant ecological areas in the Lower Eastern Shore. The long-term interest in protecting tidal wetlands is clearly shown in the large acreages protected in the Fishing Bay, Transquaking River and Tangier Sound watersheds. It may also be noted that the difficulty of using these wetland areas for agriculture or other human purposes has made them somewhat easier to acquire than upland areas.

Indicator Use

Publicly owned lands offer opportunities to provide “laboratories” to study differing approaches to resource management and watershed restoration, while private lands under conservation easement may offer good opportunities for restoration work, since the owners have committed to their long-term conservation.

“Green Infrastructure” is a concept being developed by DNR to identify hubs and corridors of the State’s most significant ecological lands as a guide to protecting Maryland’s biological diversity, complementing Smart Growth and resource-based economic development efforts. Aggregated data like those reflected in this indicator are probably less important as a guide to future conservation activities than the locations of particular properties, as was done as part of the Green Infrastructure initiative. Aggregated data do, however, help in tracking how much land in the Green Infrastructure will remain in the future because it has been protected by one formal mechanism or another. Finer scale maps of ecologically valuable lands and of currently protected lands can help to guide both public and private land conservation activities and the establishment of compatible land uses and management practices for nearby lands.

Land Protected for Natural Resource Conservation



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Summary of Terrestrial System Indicator Values

Table 5 provides the values for each indicator in each watershed used to develop the maps on the preceding pages. Note that the Protected Land indicator was not used in calculating the number in the last column, which shows the number of times the watershed fell into the lowest-rated 25% of watersheds for the remaining seven indicators in this theme. Watersheds with higher acreage of protected lands may offer more opportunities to implement restoration activities than those with lower acreage. Although the data used to construct the indicator are somewhat old, it is noteworthy that there is no protected land in two of the watersheds and very little in Wicomico Creek. For almost all of the other indicators, the Lower Wicomico River watershed was rated in the lowest quartile. The Honga, Wicomico River Head, Big Annemessex, Marshyhope, Tangier Sound and Pocomoke Sound watershed were low-rated for about half these indicators.

Table 5
Watersheds and Terrestrial Indicators

Watershed Name	% Watershed Forested	% Watershed in Interior Forest	Average Forest Patch Size (ac)	Edge Density (ft/ac)
Lower Wicomico River	43.1	16.8	829.9	83.9
Honga River	35.8	11.1	974.6	78.7
Big Annemessex River	42.9	18.0	465.7	81.2
Marshyhope Creek	41.4	16.4	980.8	71.8
Wicomico River Head	46.6	20.5	777.7	78.1
Tangier Sound	11.1	1.4	62.0	42.3
Upper Pocomoke River	52.9	29.0	1525.3	64.1
Pocomoke Sound	44.4	18.1	906.7	78.8
Nanticoke River	45.0	20.8	1092.6	58.7
Wicomico Creek	55.3	26.1	1157.3	84.1
Monie Bay	44.9	23.1	1071.9	63.1
Nassawango Creek	67.6	40.5	3225.4	62.2
Transquaking River	43.4	19.9	1533.3	66.7
Fishing Bay	45.6	29.3	4117.6	40.7
Dividing Creek	73.5	44.1	2285.4	63.0
Manokin River	46.0	23.7	1842.4	69.6
Lower Pocomoke River	55.9	28.5	1397.4	74.5

continuing

Watershed Name	Road Density (ft/ac)	Population Density (persons/ac)	Protected Land (ac)	* Number of Times in Lowest-rated 25%
Lower Wicomico River	40.4	0.33	1,280	6
Honga River	7.4	0.05	0	4
Big Annemessex River	12.4	0.12	3,062	4
Marshyhope Creek	21.6	0.12	3,011	3
Wicomico River Head	45.4	0.34	0	3
Tangier Sound	4.4	0.02	9,061	3
Upper Pocomoke River	18.1	0.23	1,025	2
Pocomoke Sound	11.5	0.12	5,690	2
Nanticoke River	15.7	0.26	6,575	2
Wicomico Creek	21.8	0.21	15	2
Monie Bay	9.6	0.12	4,863	1
Nassawango Creek	12.8	0.22	2,857	1
Transquaking River	13.3	0.1	7,884	1
Fishing Bay	7.8	0.1	29,513	1
Dividing Creek	11.5	0.15	5,528	0
Manokin River	16.5	0.12	6,414	0
Lower Pocomoke River	18.0	0.13	9,752	0

*Does not include the lowest-rated values in the Protected Lands Column.



Conservation of Biological Diversity

In addition to their intrinsic interest, diverse natural communities in Maryland are more resilient to the effects of human activities and natural hazards than less diverse areas. Interest in biological diversity has grown out of earlier concern for rare and endangered species as both professionals and lay environmental activists are taking a broader or more holistic look at maintaining entire ecosystems, attending to interactions among species, like predator-prey relationships, as well as individual ecosystem components. Protecting the best examples of Maryland's native communities is a component of this issue. Lands representative of Maryland's biological diversity should be protected through public ownership or permanent easement in buffered core areas in order to preserve these diverse communities. Our land protection efforts, both fee acquisition and acceptance or purchase of conservation easements, have often not been directed by this concept, and the knowledge base to support this kind of decision-making is still being developed. The result is that DNR's public estate probably does not at present incorporate the most diverse and valuable natural areas in the State.

Attention to ecological processes also characterizes interest in biological diversity. Particular attention has been focused on reproductive processes in response to declines in key species, like eagles, declines that resulted from reproductive failures induced in the 1960's and '70's by pesticide contamination. Nesting success is also an important focus of attention for other species.

Stressors and Sources

Many species have particular habitat requirements for different life stages, for example reproduction. As area-sensitive nesting species, many bird species are affected by habitat loss and fragmentation. For some species of birds, loss of *interior forest*, at least 300 feet from an adjacent type of land cover, eliminates the required habitat for nesting, while forest fragmentation results in reduced or no reproductive success, due to increased predation and parasitism on nests and nesting birds.

Water birds like herons nest in a few large colonies; these species as well as bald eagles require wooded shorelines and other wooded areas in close proximity to tidal waters to support large numbers of nests. Increased development of wooded shorelines and increased human activities within these areas can render the habitat unsuitable for nesting. As top predators, these birds also depend upon a stable and healthy prey base of fish and other aquatic animals.

While some specialized habitats of interest in protecting diverse species, such as the Delmarva Bays of the Eastern shore, have received a substantial amount of attention, not all areas important to conservation of biological diversity are highly evident in the landscape. These are highly susceptible to loss to human land uses like farming or residential development. Costly and comprehensive study is only now nearing completion to help to identify these areas and determine their protection status so that informed decisions can be made for their conservation.

Lower Eastern Shore Issues

Perhaps reflecting the relative newness of interest in biological diversity in Maryland, the Steering Committee for the Lower Eastern Shore Conservation and Restoration Action Strategy, in identifying pertinent issues for their area, did not consider any related to protecting or enhancing biological diversity.

Management Programs

DNR is moving to an ecosystem approach to management in order to improve stewardship of the State's natural resources. Because the issue of protection of biological diversity and associated ecosystem concerns is new relative to the long-standing public concern with environmental pollution, public education and outreach are especially important management approaches. DNR has several particular programs focused on biological diversity:

- ***Mapping of community alliances***, in cooperation with The Nature Conservancy, will allow DNR to identify important landscapes, improving the Department's ability to characterize watersheds. Mapping should be completed within the calendar year.
- ***The Ecosystem Management Council*** provides a focal point for the Department's interests and activities related to biological diversity. The Council fosters cross-disciplinary interactions and has sponsored both a conference and graduate-level training in ecosystem-based management.
- ***GAP*** is a program to identify ecologically important lands throughout the State (as part of a multi-state effort) and determine which are not currently protected for their natural values.
- ***The Nutria eradication program*** seeks to overcome the effects of the introduction of a non-native species that has proliferated at the expense of native species in Lower Eastern Shore marshes such as those around Fishing Bay and Blackwater. The "invasion" of non-native species is considered by many conservation biologists as the #1 threat to maintaining biological diversity.

A greater number of programs in both the public and private sectors which protect land for conservation purposes have a particularly important role to play in the protection of biological diversity:

- ***DNR's Program Open Space*** provides funding for the acquisition of properties significant to the protection of biological diversity. Recent acquisition of over 50,000 acres from Chesapeake Forest Products will provide an opportunity to expand this interest, as well as forestry, in the Lower Eastern Shore.
- ***The Nature Conservancy*** program of acquisition and management of special lands has focused heavily on the Nassawango Creek, a tributary to the Pocomoke River.

- *The Conservation Fund's* continuing acquisition of important and fragile areas has contributed greatly to protecting the greenway in Fishing Bay and, more recently, facilitated the purchase from Chesapeake Forest Products.
- *The Maryland Environmental Trust* holds conservation easements on private lands.
- *The Lower Shore Land Trust* also holds conservation easements on private land, often in conjunction with the Maryland Environmental Trust.

Program Issues and Observations

- ✓ On one hand, an observation was made that there are often no real management plans developed to protect particular species; on the other hand, one program manager felt that efforts to protect the Delmarva Fox Squirrel in the Chesapeake Bay Critical Area were going beyond what was necessary.
- ✓ Data are still not available to fully characterize Maryland's biological diversity or to map the various communities of interest, which hampers efforts to identify and protect important natural areas in a systematic manner.
- ✓ Several interviewees felt that, in proportion to the amount of money available for restoration activities, there was little money available for protection efforts (through fee simple or easement purchase).
- ✓ Watershed groups and land trusts described the need for the willingness to work with "unlikely" partners if they were going to be successful in making progress on restoration and protection efforts. One watershed group, the Nanticoke Watershed Alliance, was described as being successful in pulling together diverse interests and making progress on difficult issues.
- ✓ Several program managers felt that the local governments in the area were making good progress in trying to institute conservation and protection measures through comprehensive plans and regulations; however, some felt that there also needed to be better implementation of the plans already in place. Lack of local political support was cited as hampering truly innovative mechanisms from being implemented.
- ✓ The Maryland Environmental Trust could do a better job of providing good technical and legal assistance to local land trusts if it had more staff. Also, the easement acquisition process could be made more effective if the Trust focused on the administrative and legal issues and allowed the local land trusts to handle the landowner contacts and contract negotiations. It was also noted that the land appraisal process with the Department of General Services was too cumbersome and time-consuming.

- ✓ Local land trusts and others that accept easements need additional funds to effectively monitor the conditions of the easement over time.
- ✓ While the Rural Legacy Program was generally praised, one program manager observed that the State could have saved money overall and been as, or more, effective by giving more money to local governments and land trusts and hiring more Program Open Space staff.
- ✓ Watershed groups, land trusts and environmental groups all cited lack of data for sub-watersheds (Maryland 12-digit watershed code) and specific stream reaches, as well as the ability to analyze and use the data through Geographic Information Systems as obstacles to more efficient and effective service delivery.
- ✓ There are some State programs that are working at cross purposes. For example, the restrictions on cutting trees within 50 feet of a Wetland of Special State Concern that contains Atlantic White Cedar allows species that may invade the sensitive wetland area to remain, thereby threatening the biological integrity of the wetland. Selective cutting of the buffer may benefit the wetland more over time. Also, some program managers noted that current intensive management of some federal and State lands was inconsistent with the protection of biological diversity. It was also noted that if DNR and MDA worked together, more progress could be made in protecting and restoring habitat and water quality.

The Indicators

The indicators which follow were selected by DNR staff to help to describe the biological diversity of the Lower Eastern Shore. They are based on available information, most of which has compiled for other purposes and some of which contains relatively few data points for the region. Improving coverage of data for existing indicators and developing additional indicators are both programmatic needs for dealing more comprehensively with biological diversity.

- Wetlands of Special State Concern
- Sensitive Species Areas
- Imperiled Aquatic Species



Wetlands of Special State Concern

The Indicator

Wetlands provide habitat to plants and animals that have adapted to the unusual conditions that exist there: saturated soils, anoxia (lack of oxygen) of the soil, soils with high metals content, a reduced range of temperature fluctuations and others. Wetlands provide a refuge for plants that have not developed successful adaptations to dryness and for animals that have not developed reproductive methods independent of standing water. Amphibians such as frogs and salamanders, as well as a large number of insect species, require external water to reproduce successfully. Wetlands provide this essential water. Wetland conditions may also protect certain species that do not require wet conditions by excluding predators or competitors that cannot tolerate these conditions.

Maryland's Heritage Program keeps data on species that are uncommon, rare or threatened with local extinction. In Maryland certain wetlands with rare, threatened, or endangered species, or unique habitat, receive special attention. The Code of Maryland Regulations identifies these as Wetlands of Special State Concern (WSSC) and affords them certain protections, including a 100 foot buffer from nearby development. In general, the US Fish and Wildlife Service's National Wetlands Inventory provides the basis for identifying these special wetlands. Additional information, determined from field inspections, is used to identify, classify and map these areas, including the buffer. The accessible portion of the data base is protected areas expressed in acres. There may be more than one protected species present in the protected area.

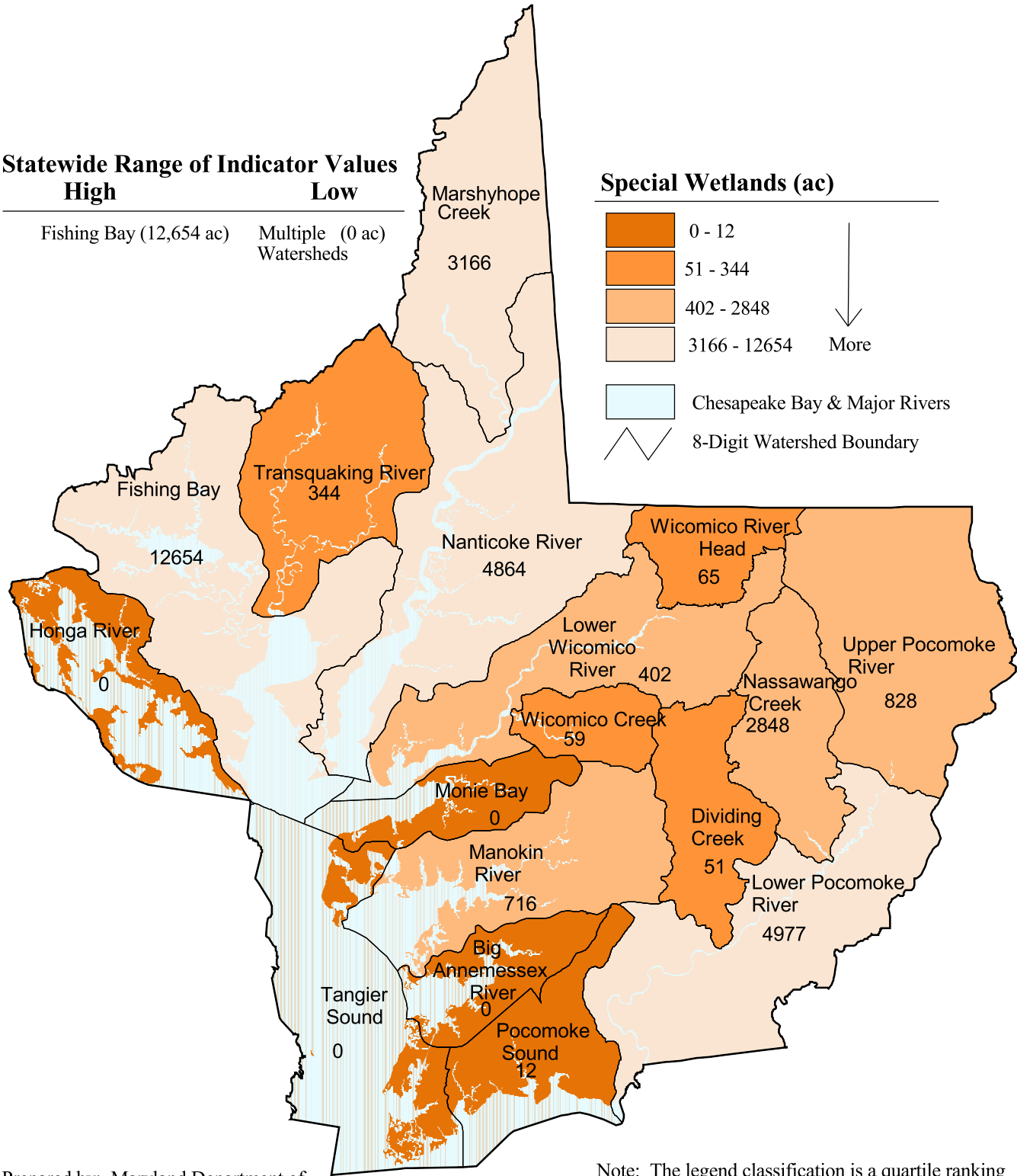
Interpretation

Wetlands of Special State Concern are essential for preserving biological diversity. Fishing Bay, the Nanticoke River and the Lower Pocomoke River each contain high acreage of WSSC wetlands, which implies a high number of protected species, plants and animals. These are watersheds with a high environmental quality that needs to be protected and preserved. They are also particularly sensitive to environmental degradation in many forms. The wetlands in these watersheds are unusually large and diverse, offering a variety of habitats.

Indicator Use

Areas which score high on this indicator are areas with high environmental quality, which need to be protected. Since there appears to be growing public appreciation for the unusual and the rare, areas with major or unique wetlands may have a substantial potential for developing ecotourism as an element in their economies.

Wetlands of Special State Concern



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Sensitive Species Areas

The Indicator

Some species of both plants and animals have been identified as rare, threatened or endangered, in order to receive special protection under both State and federal law. They are the most vulnerable inhabitants of our ecosystems and thus most sensitive to human impacts. The data from which this indicator was derived were developed by the Department of Natural Resources' Wildlife and Heritage Division for the purpose of reviewing proposed projects for impacts to rare, threatened or endangered species and their habitats, as well as other sensitive species, like waterfowl, that are of particular interest.

The data were first collected in the field by biologists with the expertise to document and verify the presence of rare, threatened or endangered species or important biological communities in generalized areas referred to as "Sensitive Species Project Review Areas." Although the data set is the most complete source of information on Maryland's defined sensitive species and significant natural communities, it does not represent an exhaustive or comprehensive inventory of those resources. It is also very generalized information.

Interpretation

The Lower Eastern Shore Tributary Basin, although heavily impacted by man's activities since European settlement began over 350 years ago, still contains significant biological resources. The area is unique in its support of waterfowl populations, raptors (such as Bald Eagles), and listed rare, threatened or endangered plants and wildlife. The geology and hydrology of the area combine to create very diverse plant communities, from upland forest and shrub areas, to extensive salt marshes and wet meadows, to flooded cypress swamps. From a statewide perspective, in terms of total acreage of Sensitive Species Areas, the Lower Eastern Shore Tributary Basin contains 9 of the top 20 watersheds that flow into Chesapeake Bay. The Fishing Bay watershed contains the greatest acreage of any watershed in Maryland. This is due to the presence of large and highly valued wetland complexes, notably the Blackwater National Wildlife Refuge and the Fishing Bay Wildlife Management Area, which are important for waterfowl, finfish and shellfish habitat, and water quality.

Indicator Use

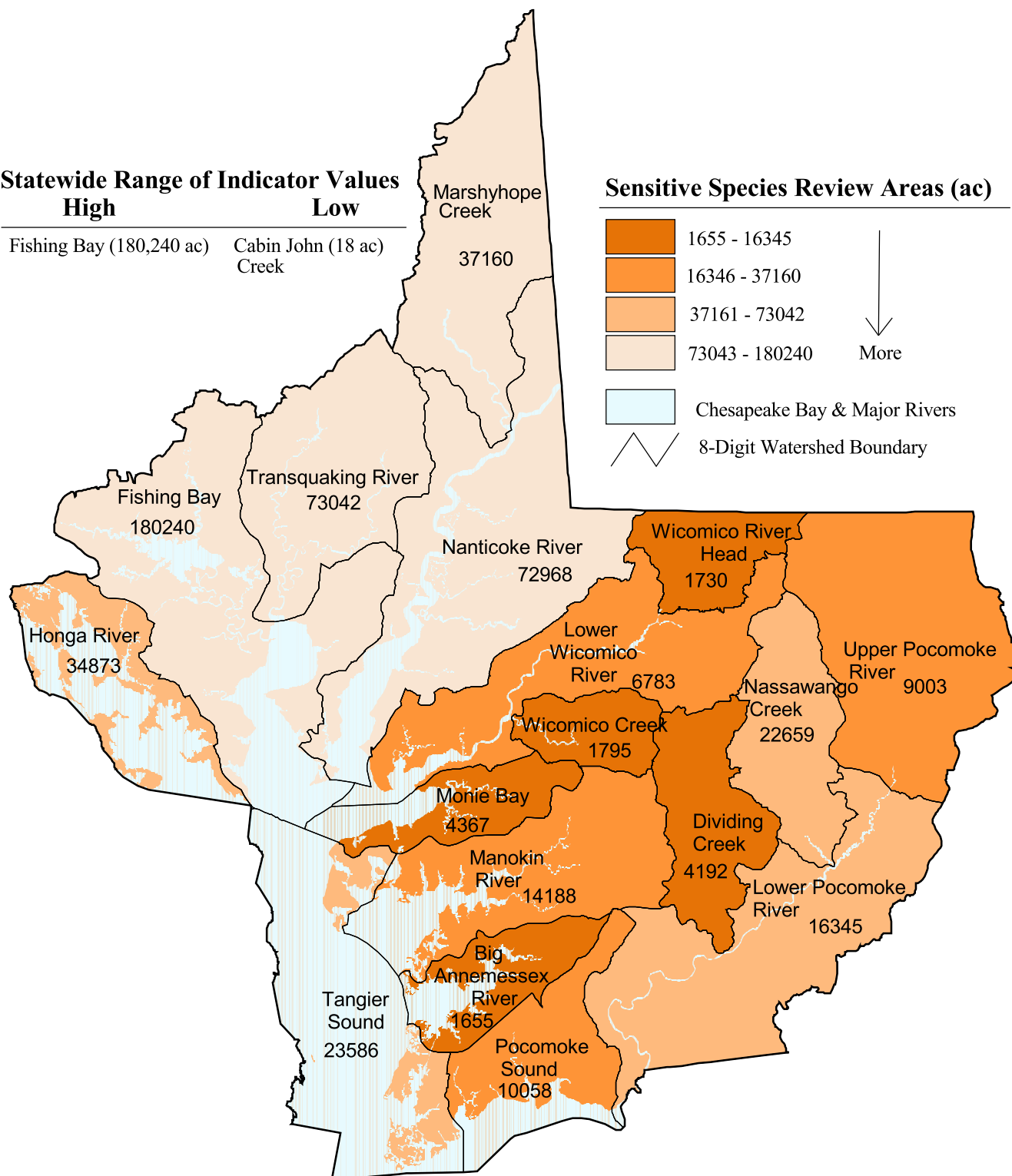
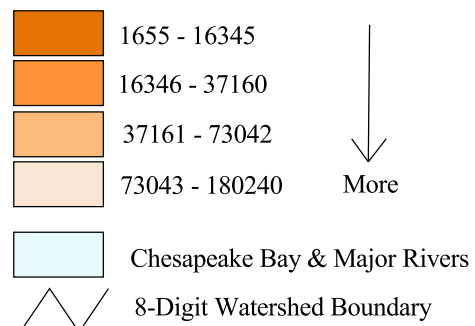
This indicator provides a way of measuring the amount of unique and sensitive habitat in a watershed. Those interested in protecting these resources will be able to see which watersheds contain the greatest amount and which contain the least, and focus their efforts accordingly. Given the nature of the Lower Eastern Shore Tributary Basin, one could also note the size of the watershed relative to the acreage of Sensitive Species Project Review Area and determine which watersheds have been the most impacted by man, therefore requiring restoration (to return biological function) and protection efforts (to preserve what is left).

Sensitive Species Areas

Statewide Range of Indicator Values

High	Low
Fishing Bay (180,240 ac)	Cabin John (18 ac) Creek

Sensitive Species Review Areas (ac)



Prepared by: Maryland Department of Natural Resources

Note: The legend classification is a quartile ranking of the watersheds within the Lower Eastern Shore Tributary Basin.

December 1999

Imperiled Aquatic Species Index

The Indicator

Maryland DNR's Wildlife and Heritage Division lists particular species, including some species of amphibians, fish, crayfish and mussels, as rare, threatened or endangered. Information on where these aquatic animals have been found is also maintained to help assure their habitats are disturbed as little as possible by human activities.

To develop the index mapped in this indicator, distributions of these aquatic animals within the 8-digit watersheds were determined using Maryland Biological Stream Survey data and scored from 0 -10, based on the number of sites with rare species, their status (endangered, rare...), and the diversity of aquatic animals. The indicator, which points primarily to the condition of natural resources might also be considered to suggest vulnerability to human-induced adverse impacts; it was used in the Unified Watershed Assessment to help determine watersheds classified for conservation.

Interpretation

The presence of rare, threatened or endangered species indicates the presence of suitable habitat, usually unmodified or minimally modified by human activity. Species are conserved by preserving their habitat. It should be noted that while an 8-digit watershed may score poorly according to several of the criteria used in this indicator, there may be a small pocket or stream where rare, threatened or endangered animals live, also that some threatened or rare species can live in an area that suffers from several types of pollution.

Two watersheds in the Lower Eastern Shore Tributary Basin, Marshyhope Creek and the Upper Pocomoke River, received the highest possible score for this indicator, and five other watersheds were also highly rated.

Indicator Use

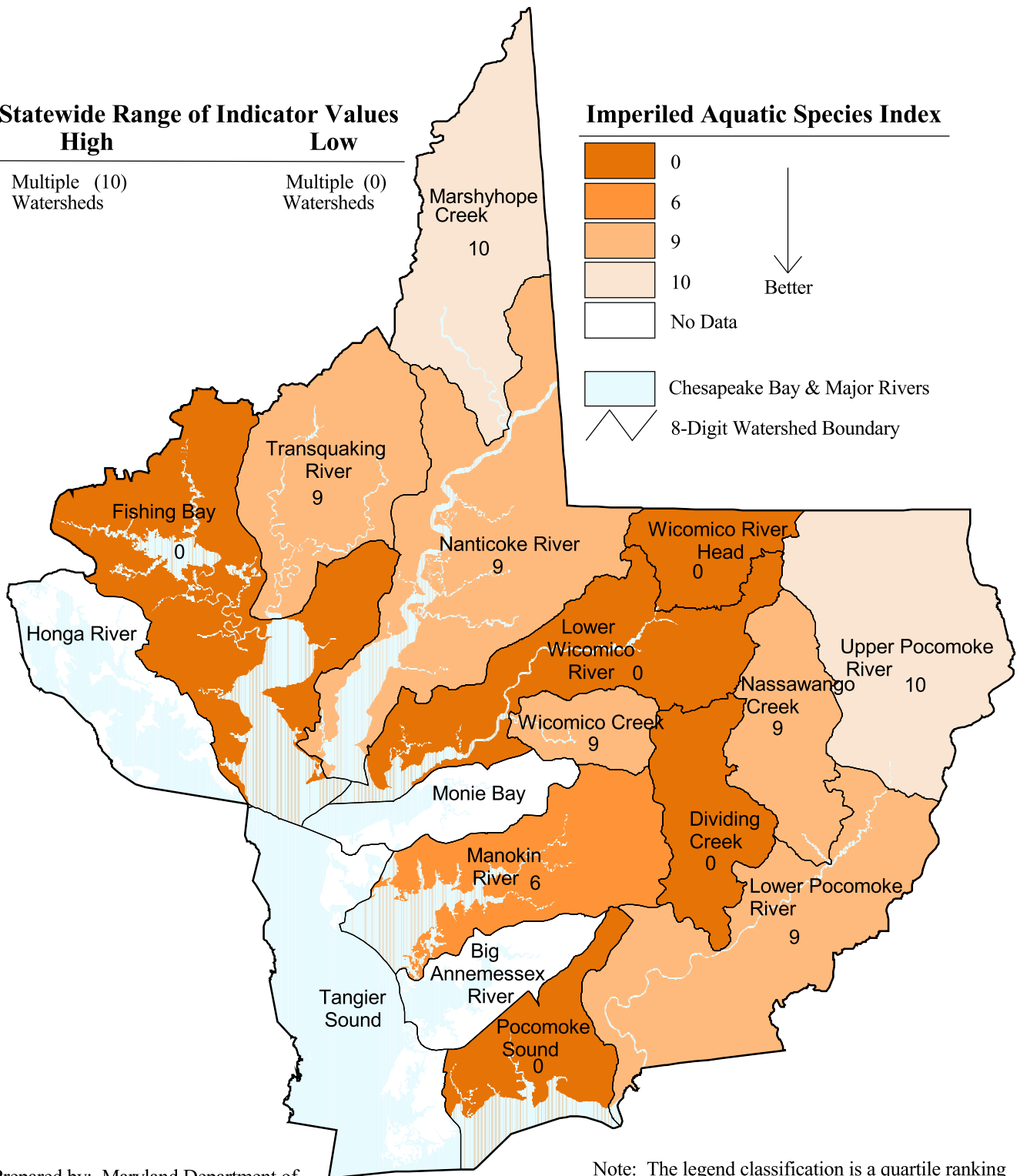
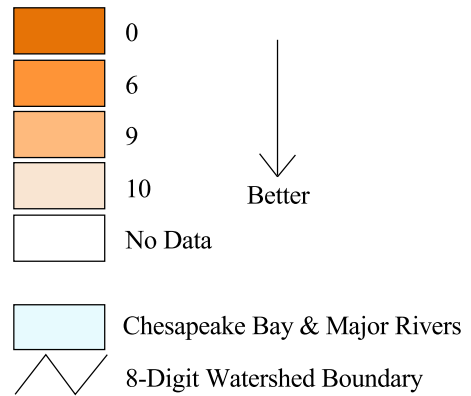
The preservation of biological diversity is a policy of the State of Maryland. Important and large-scale conservation efforts, both public and private, have been under way for many years in Marshyhope Creek, the Nanticoke River, Nassawango Creek and the Lower Pocomoke River. Other watersheds highly rated for this indicator offer additional opportunities to protect the State's biological diversity.

Imperiled Aquatic Species Index

Statewide Range of Indicator Values

High	Low
Multiple (10) Watersheds	Multiple (0) Watersheds

Imperiled Aquatic Species Index



Prepared by: Maryland Department of
Natural Resources

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Summary of Biological Diversity Indicator Values

The preceding sections of this report detailed information which might point toward need for watershed restoration, and low-rated watersheds were called out. Biological diversity indicators point to the presence of important natural resource values. We are, therefore, more interested in watersheds with high ratings for these indicators, those with the lighter tones on the preceding maps, where long-term conservation is the more important strategy. The final column in Table 6 highlights the Lower Eastern Shore watersheds that are higher-rated in this theme.

Table 6
Watersheds and Biodiversity Indicators

Watershed Name	Wetlands of Special Concern (ac)	Sensitive Species Area (ac)	Imperiled Aquatic Species Index	Number of Times in Highest-rated 25%
Marshyhope Creek	3166	37160	10	3
Nanticoke River	4864	72968	9	2
Fishing Bay	12654	180240	0	2
Lower Pocomoke River	4977	16345	9	1
Upper Pocomoke River	828	9003	10	1
Transquaking River	344	73042	9	1
Tangier Sound	0	23586		0
Dividing Creek	51	4192	0	0
Nassawango Creek	2848	22659	9	0
Monie Bay	0	4367		0
Wicomico Creek	59	1795	9	0
Wicomico River Head	65	1730	0	0
Pocomoke Sound	12	10058	0	0
Big Annemessex River	0	1655		0
Manokin River	716	14188	6	0
Lower Wicomico River	402	6783	0	0
Honga River	0	34873		0

Viability of Resource-based Industry

The well-being of the population is a precondition for public concern for broader, non-personal issues, including environmental stewardship. Historically, and into the present, a number of resource-based industries have played a substantial role in the economy, and thereby the well-being, of the State. The challenge is managing these economic activities in an environmentally responsible manner and insuring that the resources on which they depend remain available to support them.

Fishing, agriculture, mining, forestry, and, to some extent, recreation are all economic activities which depend upon the State's natural resources to support them. Agriculture and forestry are backbones of the economy of the Lower Eastern Shore, fishing is a traditional occupation of Bay area communities, and ecotourism—a specialized form of recreation—is of growing interest in the region.

Stressors and Sources

Both natural and human-induced stressors affect the natural resource base for important economic activities in Maryland, which are also subject to the ups and downs of the national economy and changes in technology.

The seafood industry has suffered from the effects of both water pollution (and its attendant changes in the aquatic ecosystem) and disease on desirable commercial species. Marketing problems were exacerbated by public concern over the safety of seafood consumption during the scare caused by *Pfiesteria piscicida*, which attacks some fish under conditions which are still not completely understood. Although human consumption of fish was not the means of transmission of the toxic effects of *Pfiesteria*, seafood sales were affected.

The forest industry is stressed by increasing physical fragmentation and the division of remaining forest land into multiple ownerships. Agriculture is stressed primarily by natural conditions, like the recent drought, and by both short-term fluctuations and long-term trends in the national economy; however, as urban uses creep further and further into agricultural areas, incompatibilities between the new residents and agricultural practices cause irritation at best and sometimes efforts to curb some agricultural activities. The perception of threat from environmental regulations poses additional stress.

Lower Eastern Shore Issues

Economic factors were clearly in the minds of members of the Steering Committee for the Lower Eastern Shore Conservation and Restoration Action Strategy when they brainstormed issues, although in a rather generalized sense. Two issues were considered by the Steering Committee to be priorities in this area:

- The economy of the Lower Shore, including the need for diversity, the impacts of land costs on achieving economic development and diversification, the impacts of regulatory barriers, and the need for incentives.
- Maintenance of forestry as an economic sector of importance to the region, with possible needs for incentives similar to those for agriculture.

Another issue considered important by the group dealt with the way an on-going program was currently operating:

- Agricultural land preservation program in its current operation—whether the right lands are being protected.

Three other issues related to resource-based industry themes were raised but were not considered priorities to pursue at the present time:

- Tourism, both as an economic sector that is perhaps in competition with other sectors and as an environmental impact.
- Public boat access, both in terms of availability/distribution of sites and in terms of potential conflicts in use and conflicts with environmental protection.
- Oysters—population and health, both as an economic resource and as ecosystem components.

Management Programs

Relatively few programs have been identified that deal with the resource-based economy in Maryland. Those that were identified were found primarily at the State level and provide some mix of regulatory and incentive approaches.

- ***Fishery Regulation and Licensing*** (DNR) programs work to sustain the harvest of commercial species while maintaining viable populations and securing some equity between commercial and recreational fishing. The Natural Resources Police enforce these laws and regulations.
- ***The Agricultural Land Preservation Program*** (MDA) provides for the purchase of easements, valued in accordance with the property's development value, on agricultural land, as an incentive to maintaining it in agricultural use.
- ***Rural Legacy Program*** (DNR) is a rural landscape protection approach that encourages local governments and private land trusts to identify Rural Legacy areas and to competitively apply for funds to complement existing land conservation efforts or create new ones. No Rural Legacy areas have been approved in the Lower Eastern Shore Tributary Basin.
- ***Program Open Space Waterway Improvement*** (DNR) funds can be used to build boat launch and related facilities to help support recreational boating.

- ***The State Forest and Park Service*** (DNR) manages a number of land units in the Lower Eastern Shore Tributary Basin that exemplify, and provide public access to, the wealth of diverse ecosystems of the region.
- ***Reforestation/Timber Stand Improvement Tax Deduction*** allows owners of small to medium amounts of commercial forest to deduct double the direct costs associated with certified activities from their gross income for Maryland tax purposes.
- ***The Forestry Incentive Program*** (DNR) provides reimbursement up to 65% of costs for tree planting, site preparation and timber stand improvement practices.

One private-sector program in support of continued forestry operation was identified:

- ***The Glatfelter Cost-Share Program*** provides 50 percent cost share assistance to land-owners for planting eligible seedlings. Landowners in the Lower Eastern Shore Tributary Basin who are willing to plant loblolly pine are eligible for assistance.

One locally-based program was identified that may help to get a handle on the economic importance of tourism to the Lower Eastern Shore Tributary Basin:

- ***The Lower Eastern Shore Heritage Committee*** is hoping to develop a management plan that should help address the issue of the effects of tourism on local economies.

Program Issues and Observations

- ✓ More indicators, and the data to support them, are needed to deal with how Maryland's economy is tied to its natural resource base. While there may be statewide data on resource-based industrial sectors, there are no indicators developed to track agriculture, forestry or fisheries as economic sectors in subareas of the State like watersheds or even Tributary Basins, nor to track participation in programs intended to support these industries.
- ✓ Prices offered for agricultural easements have generally not been attractive enough to encourage widespread use of this approach to supporting the agricultural economy.
- ✓ As urban and suburban areas spread out into adjacent rural areas, conflicts between the new residents and daily operation of farms and commercial forests are increasing. Also, with farmlands and forests disappearing, there is concern that there may not be a sufficient economic base to allow remaining agricultural and forestry operations to continue.

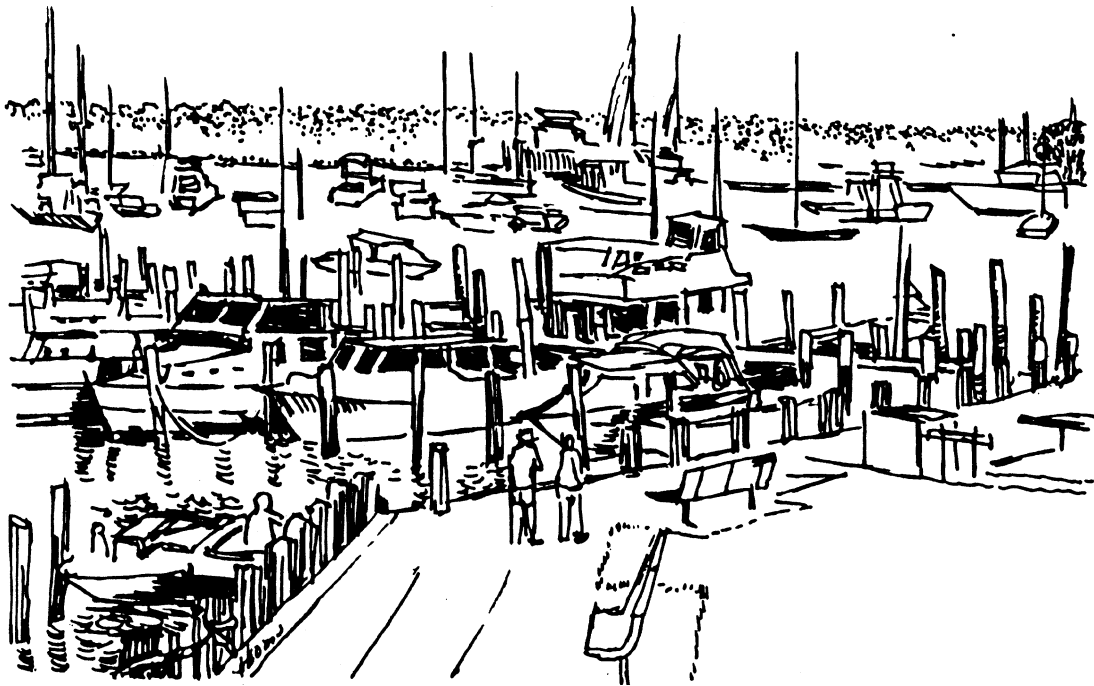
- ✓ There should be a concerted effort to make information available to local politicians, planners and Chambers of Commerce on the economic benefits of the remaining natural/rural areas and of ecotourism.
- ✓ Creating better water access will increase use and awareness of the value of waterways and wildlife.

Unlike the preceding sections, this theme does not include a summary table of values, in part because there are only two indicators and in part because this information does not have high relevance to the development and targeting of restoration actions.

The Indicators

In addition to a general paucity of indicators to track resource-based industry in Maryland or any region in the State, there is a serious mis-match between the indicators available and both the issues identified for the Lower Eastern Shore and the programs available to deal with the topic in general. The two indicators in this section are based on available information and deal, partially, with only two of the resource-based industry sectors we have identified, recreation and agriculture. Clearly there needs to be effort expended to develop indicators which capture the economic health of the fishing, forestry and mining industries.

- Number of marina slips
- Agricultural land easements



Marina Slips

The Indicator

Boating is an important recreational activity in Maryland and is an economic force in some communities. Recreational boating also has the potential to impact water quality. For example, water quality may be degraded by discharges of petroleum products and improper disposal of human waste, as well as through additional erosion and sedimentation caused by boat wakes. On the other hand, by providing first-hand experience with the Chesapeake Bay and its tributaries, recreational boating can help to build a constituency for programs designed to protect or restore the Bay, including those needed to ameliorate the impacts of the boats themselves. Although it does not capture the entirety of the economic importance of recreational boating to a locality—boats that are not left in the water are not counted, for example, nor transient boats spending a relatively short time in any particular area—one available measure is the number of marina slips in a watershed.

Maryland's Clean Marina Program has developed a database that includes the name, location, number of slips, and other information about marinas. The Marina Slips indicator is derived from this comprehensive database by summing the number of marina slips available at marinas in each watershed.

Interpretation

Marinas are located in each of the Lower Eastern Shore watersheds. Half of the 36 marinas included in the database in 1998 are found in the Honga River and Tangier Sound. Somers Cove Marina in Crisfield (Tangier Sound watershed) is the largest in the Lower Eastern Shore Tributary Strategy Basin. The facility is State-owned and maintains over 400 marina slips. Overall, Tangier Sound and Honga River are home to over half the more than 1500 available marina slips found on the Lower Eastern Shore. Historically, the maritime economy of Maryland has centered here, and recreational boating can help to maintain the human connection to the Bay as the traditional watermen's economy has declined.

Indicator Use

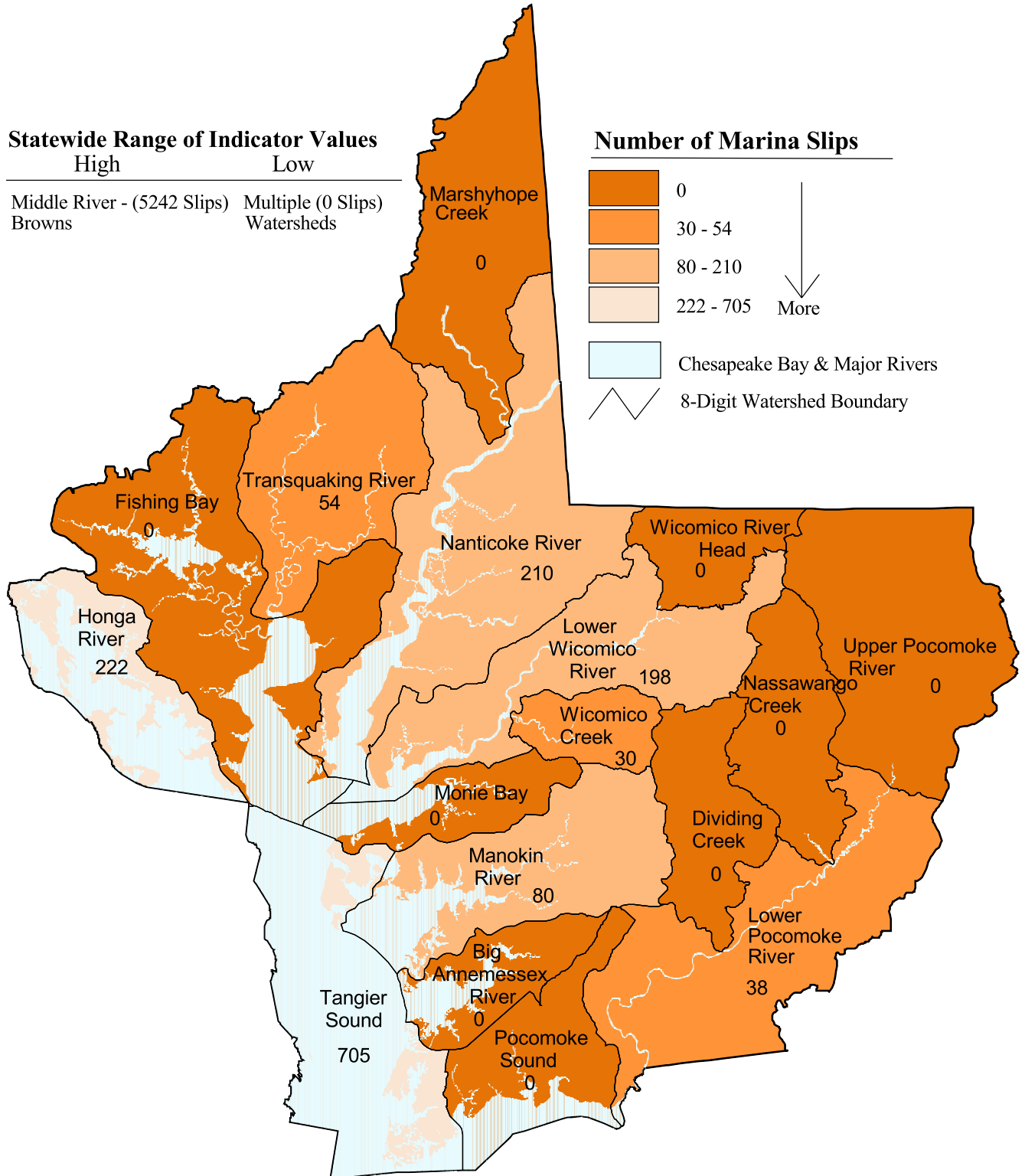
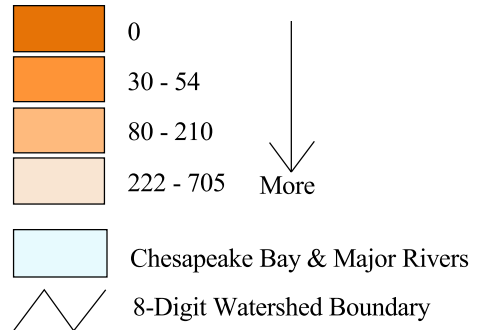
Those who derive a livelihood from the Bay and the tributary streams in its watershed, whether from traditional fishing occupations or recreational boating, have a particular interest in maintaining and restoring its quality. So do marina patrons. To promote environmental stewardship at the local level, the Maryland Department of Natural Resources' Clean Marina Program has developed goals for marina facilities that include: prevention of fuel and oil spills; elimination of raw sewage disposal into the State's waterways; recycling of waste, batteries and oil; and maintaining a clean and efficiently running boat. Concentrations of marinas and slips offer opportunities to promote this program and others, including local government and private initiatives aimed at conservation and restoration.

Marina Slips

Statewide Range of Indicator Values

High	Low
Middle River - (5242 Slips) Browns	Multiple (0 Slips) Watersheds

Number of Marina Slips



Prepared by: Maryland Department of
Natural Resources

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

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Agricultural Easements

The Indicator

Placing agricultural land under an easement represents a commitment to maintain agricultural use of the property rather than convert it to some form of more urban development. Granting or selling an easement prevents even future owners from developing the land. Where substantial acreage is covered by easements and active farming, farmers are encouraged to invest in their operations, and businesses supporting agriculture—agricultural infrastructure—can be more readily maintained. As urban type development is more contained, conflicts between agricultural interests and non-farm residents or businesses can be reduced. All of this helps maintain the agricultural economy.

Information on the numbers and locations of agricultural easements in the State is maintained by the Maryland Agricultural Land Preservation Foundation and periodically provided to DNR for inclusion in a GIS layer of protected lands. The information mapped, which is currently being updated, is from 1994.

Interpretation

Of over 300,000 acres of Lower Eastern Shore lands classified by the Maryland Office of Planning as being in agricultural use, only about 8500 acres—less than 3%—have been placed under easement protection. These roughly 70 easements, just under 10% of the State's total, account for slightly under 8% of the total State acreage protected by agricultural easements in 1994.

Reflecting Caroline County's active role in protecting agricultural lands, the Marshyhope Creek watershed leads the way in the Lower Eastern Shore Tributary Basin, with nearly 12% of its agricultural lands under easements. Barely 2% of the agricultural land in the Nanticoke River watershed is protected, although it ranks second in the Basin in acres under easement.

Indicator Use

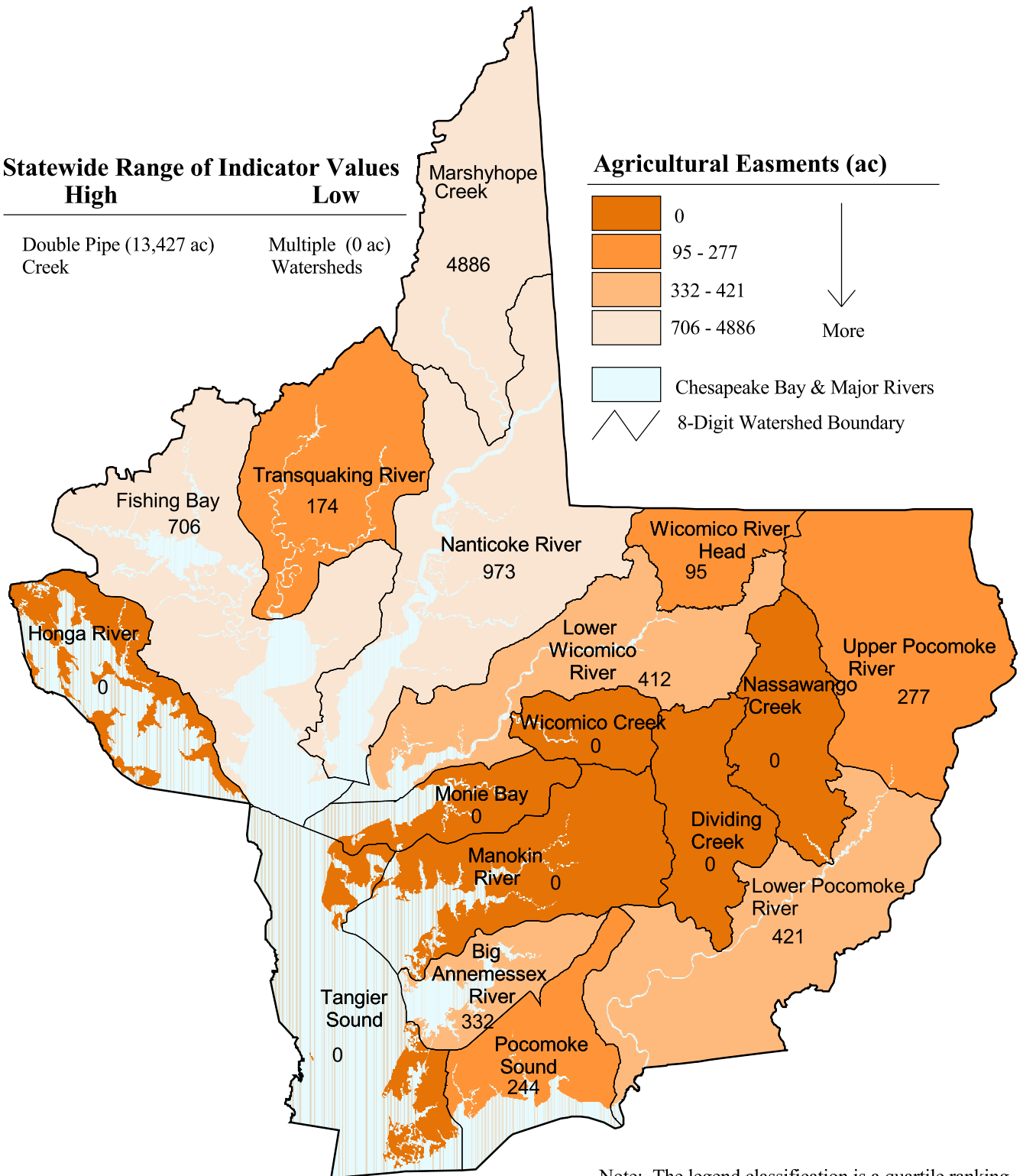
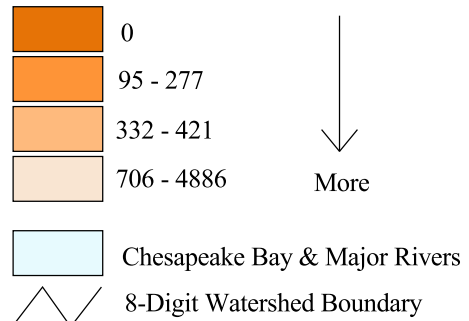
Where there are clusters of agricultural easements already, local planners may want to work particularly hard to promote the continuation of farming, including the acquisition of additional easements, right-to-farm ordinances or special marketing initiatives. Locations where individual farm owners have sold easements may also be particularly appropriate for encouraging and assisting with restoration activities, especially those that help to conserve soil and water resources necessary for the long-term productivity of the farm.

Agricultural Easements

Statewide Range of Indicator Values

High	Low
Double Pipe (13,427 ac) Creek	Multiple (0 ac) Watersheds

Agricultural Easements (ac)



Prepared by: Maryland Department of
Natural Resources

Note: The legend classification is a quartile ranking
of the watersheds within the Lower Eastern
Shore Tributary Basin.

December 1999

Summary, Findings and Conclusions

The Unified Watershed Assessment that Maryland completed in late 1998 used 17 indicators to classify watersheds as needing restoration; the results of this statewide assessment as it applied to the Lower Eastern Shore Tributary Basin, together with local knowledge brought to bear by the Steering Committee established to oversee development of this action strategy, led to a determination to focus initially on three 8-digit watersheds for implementing restoration actions: the Upper Pocomoke, Lower Pocomoke and Lower Wicomico. These watersheds are among the priority restoration watersheds designated by the Unified Watershed Assessment. They also encompass a variety of different land use conditions and involve the three counties most interested in the process. In addition, the Pocomoke is an interstate watershed, and the State of Delaware has evinced interest in continuing to work with Maryland. Finally, the largest Maryland outbreak of *Pfiesteria* had occurred at the mouth of the Pocomoke River in 1997.

In part to gain some insight into what conditions and stresses lay behind the classification of the six watersheds as priorities for restoration, and to allow for the strategy's use in conservation as well as restoration, it was decided to add additional indicators—bringing the total to 31—and to carry out a comparative assessment of the seventeen watersheds in the Basin. The preceding pages document the results of that assessment. Besides deepening our understanding of what the situation is in the three selected watersheds, the assessment can help set priorities for future work in other watersheds as resources become available.

Table 7 provides a summary of the indicator work reported above, ranking the seventeen watersheds according to the number of times their indicator values for various watershed conditions were rated among the lowest in the Basin. Only indicators in the four themes most relevant to watershed restoration are included in the summary.

Table 7
Watershed Ratings and Themes

Watershed Name	Water Quality	Aquatic System	Hydrologic Processes	Terrestrial System	Number of Times in Lowest-rated 25%
Lower Wicomico River	2	4	2	6	14
Wicomico River Head	4	2	2	3	11
Lower Pocomoke River	3	3	3	0	9
Upper Pocomoke River	3	2	1	2	8
Transquaking River	2	3	2	1	8
Marshyhope Creek	3	1	1	3	8
Nanticoke River	1	1	3	2	7
Big Annemessex River	0	2	0	4	6
Tangier Sound	0	2	1	3	6
Pocomoke Sound	0	4	0	2	6
Honga River	0	1	0	4	5

Watershed Name	Water Quality	Aquatic System	Hydrologic Processes	Terrestrial System	Number of Times in Lowest-rated 25%
Fishing Bay	1	1	1	1	4
Wicomico Creek	1	1	0	2	4
Manokin River	0	2	1	0	3
Monie Bay	0	2	0	1	3
Nassawango Creek	0	1	0	1	2
Dividing Creek	0	1	0	0	1

Not surprisingly, the three watersheds selected by the Steering Committee are among those with the greatest number of such occurrences.

Next Steps–Phase II

The assessment of Lower Eastern Shore conditions carried out in the study to date has relied on the application of Geographic Information System-based (GIS) analysis of existing data sets. Some of the limitations in the data were mentioned in earlier sections and are further discussed below. The result of the GIS analysis is to indicate which watersheds are more likely to have a prevalence of the conditions of interest than others. Phase I of the assessment assumes that in-field evaluations are more likely to uncover situations needing restoration in these watersheds.

In order to get to the point of implementing restoration actions in particular geographic locations, field investigations and intensive local review are required. To help in finding smaller watersheds in which to undertake this kind of assessment, the Steering Committee requested a look at indicator data mapped at a finer scale—the 12-digit subwatersheds that average about eight square miles in size—in the three focus watersheds. An evaluation of the resolution of data used to construct the indicators revealed that many of them became unreliable at this scale. There was consensus among the DNR staff that the Historic Wetland Loss, Percent Unforested Riparian Buffer, and Impervious Surface indicators were derived from sufficiently accurate data sources to be useful at the 12-digit scale. The composited nitrogen and phosphorus loadings to the Chesapeake Bay (which are derived from land cover data) were used in relative ranking of watersheds only, in recognition that the modeling approach used in their derivation resulted in imprecise values at such a scale.

The following maps show how these four indicators were applied to the subwatersheds in the Upper and Lower Pocomoke River and Lower Wicomico River watersheds. (The numbers used to identify the subwatersheds are for purposes of this study only and simply serve as reference numbers, since many of the streams are unnamed.) The Impervious Surface classification parallels the threshold values used in comparing the 8-digit watersheds, with 1 representing the worst conditions and 4, the best. The other maps are purely relative and classify the 12-digit watersheds into quartiles: clusters of about 25% of the total subwatersheds in the three focus

areas with values within each of the ranges shown. The ranges were established using only values applicable within the three focus watersheds. Table 8 summarizes the indicator values and shows the number of times each subwatershed was found in the lowest-rated 25%.

Table 8
Subwatersheds and Indicators Summary

Watershed Name	ID	Impervious Surface Rating*	% Wetland Loss	% Unforested Riparian Buffer	Modeled Nutrient Composite	Number of Times Listed in Lowest-rated 25%
LOWER POCOMOKE RIVER	LP13	1	68.8	56.4	9.3	3
	LP6	1	77.5	11.8	9.6	3
	LP5	3	68.0	18.6	8.3	2
	LP2	4	74.9	32.9	4.0	1
	LP8	4	83.5	32.9	1.7	1
	LP12	4	83.0	13.0	1.2	1
	LP16	4	44.2	55.3	1.5	1
	LP4	4	46.0	14.1	4.6	0
	LP7	4	43.4	19.6	6.7	0
	LP10	4	72.4	23.1	0.8	0
	LP3	4	47.7	9.8	7.4	0
	LP9	4	67.1	14.9	2.3	0
	LP1	4	31.2	26.6	2.4	0
	LP14	4	0.7		6.1	0
	LP15	4	59.5	19.2	3.3	0
	LP11	4	52.3	20.3	0.5	0
UPPER POCOMOKE RIVER	UP16	3	94.7	58.6	8.2	4
	UP13	2	90.8	57.5	8.9	4
	UP14	2	92.1	51.7	9.4	4
	UP12	4	83.6	52.1	5.6	2
	UP7	4	83.8	38.6	4.0	2
	UP4	4	75.4	1.1	0.6	1
	UP3	4	74.3	60.3	6.2	1
	UP8	4	77.6	37.1	6.7	1
	UP11	4	62.5		0.2	0
	UP15	4	66.9	38.2	2.3	0
	UP6	4	72.4	32.0	4.4	0
	UP5	4	73.2	25.4	5.2	0
	UP10	4	73.2	33.9	2.6	0
	UP9	4	73.4	22.4	4.0	0
	UP2	4	74.8	2.7	2.7	0
	UP1	4	30.1	22.7	2.1	0

Continued on next page

Table 8 (continued)

Watershed Name	ID	Impervious Surface Rating*	% Wetland Loss	% Unforested Riparian Buffer	Modeled Nutrient Composite	Number of Times Listed in Lowest-rated 25%
LOWER WICOMICO RIVER	LW9	1	78.4	10.0	53.8	3
	LW2	4	1.6	7.7	31.5	2
	LW10	4	32.3	7.7	74.6	2
	LW6	2	24.6	8.5	50.3	2
	LW8	2	23.3	9.2	54.3	2
	LW7	4	44.0	7.0	25.8	1
	LW4	4	12.6	5.2	68.1	0
	LW3	4	34.9	3.9	73.6	0
	LW1	4	5.1	5.2	48.2	0
	LW5	4	19.2	5.7	46.1	0

* 1 = >12% impervious (worst); 2 = 8-12% impervious; 3 = 4-8% impervious; 4 = <4% impervious (best).

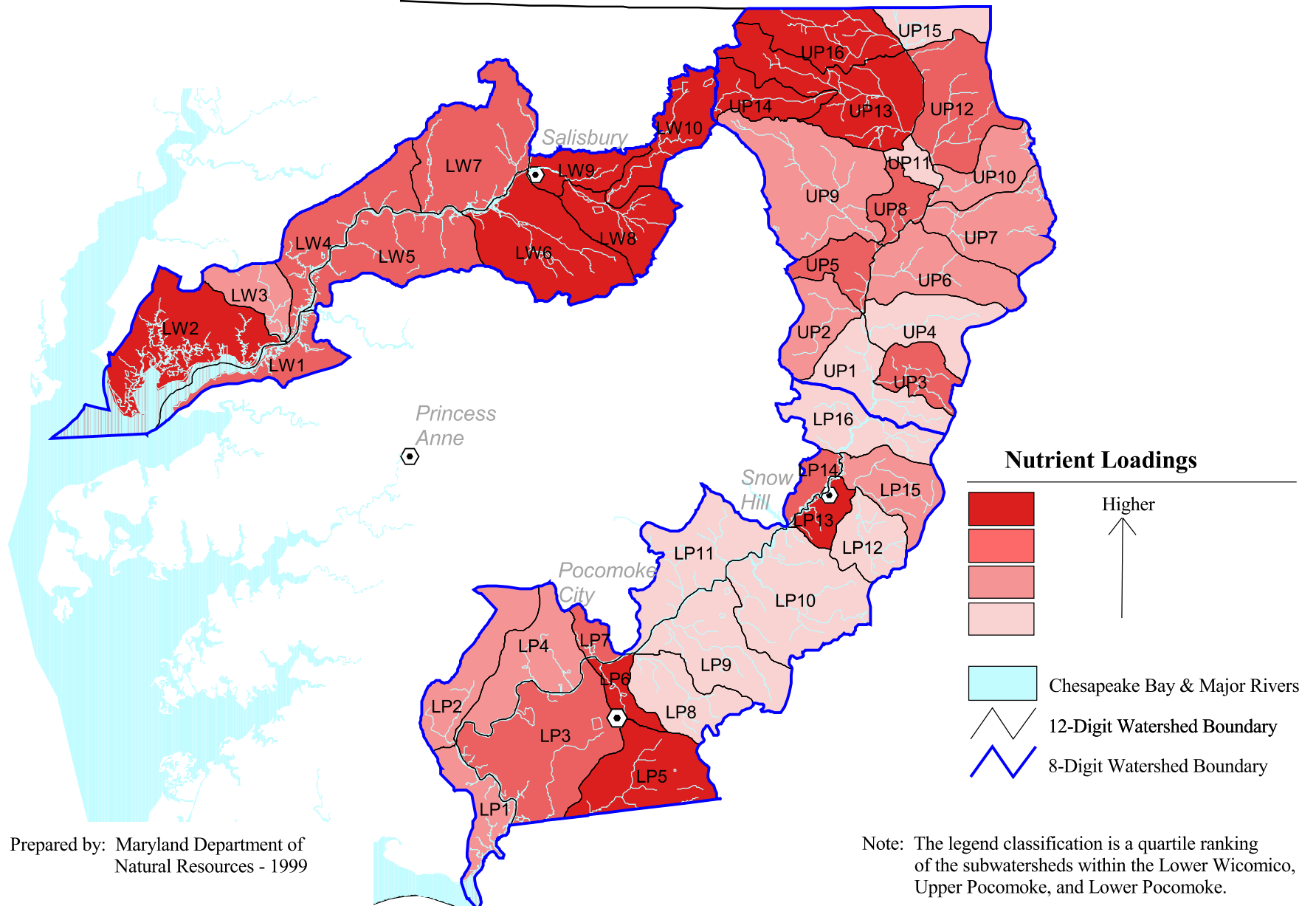
The maps and summary table were evaluated and discussed in detail by the Steering Committee, which selected one primary and one back-up subwatershed in each of the focus 8-digit watersheds:

Upper Pocomoke: UP16 and UP13
Lower Pocomoke: LP5 and LP6
Lower Wicomico: LW9 and LW6

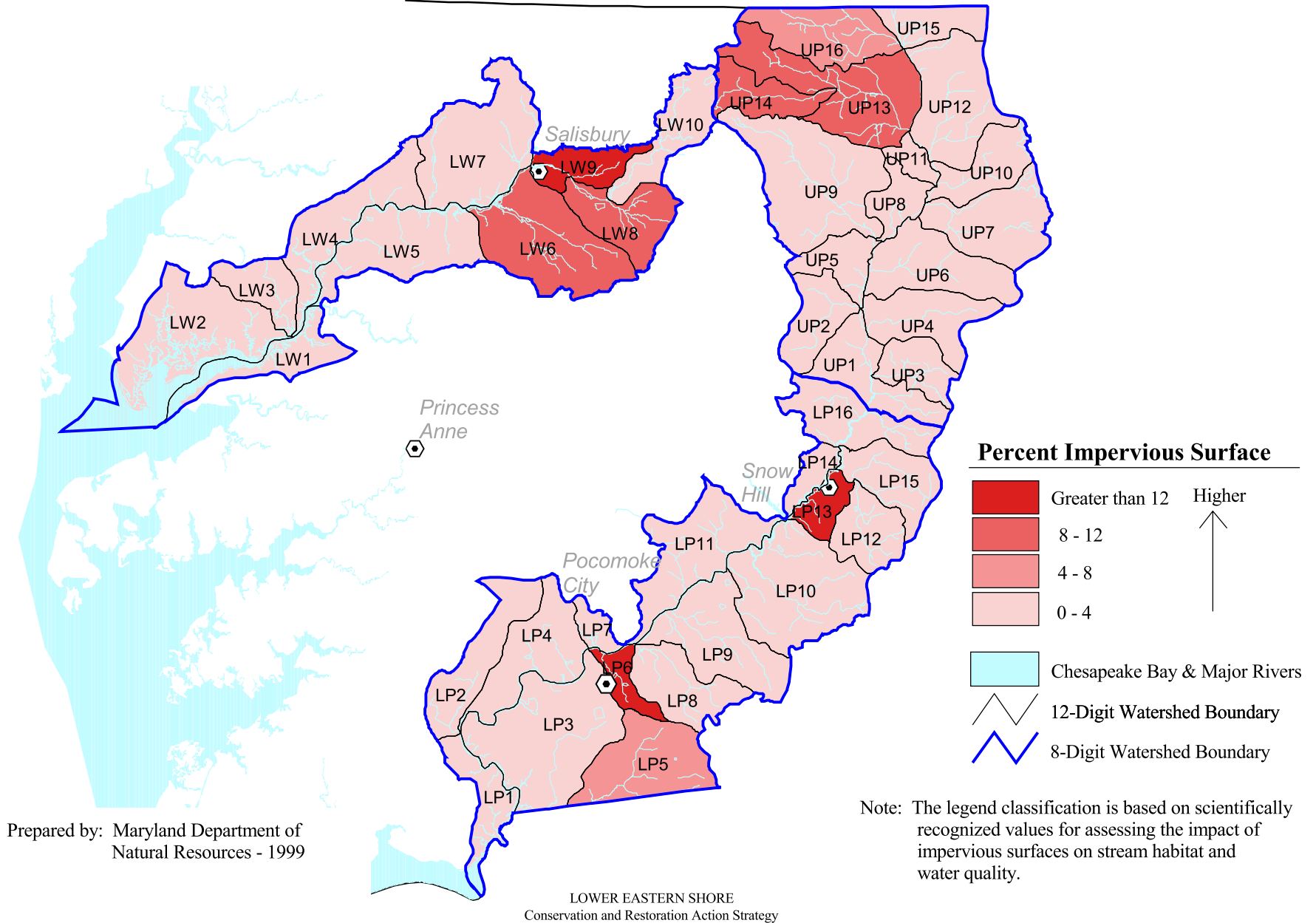
The Pocomoke selections were conditioned in part on their potential for interstate cooperation, with Delaware in one case and Virginia in the other. They also represent two distinct land use assemblages, one rural and one small town. Both Lower Wicomico subwatersheds are in the Salisbury urban area.

Now that sub-watersheds in the Upper Pocomoke, Lower Pocomoke and Lower Wicomico River watersheds have been selected, we will be initiating efforts to develop plans for accelerating the implementation of best management practices in these three watersheds, should active local partners be identified. The first step in this process will be to bring together local personnel from federal, state and local government agencies and the private sector who work with private landowners in implementing best management practices and with government agencies responsible for maintaining local infrastructure. It is our hope that in working with these experts and local landowners we can ensure that we are implementing the most appropriate best management practices in the areas where they can provide the greatest environmental benefit. This effort will most likely require additional data collection, additional training of local field personnel, outreach to landowners and funding to demonstrate innovative or under-financed best management practices.

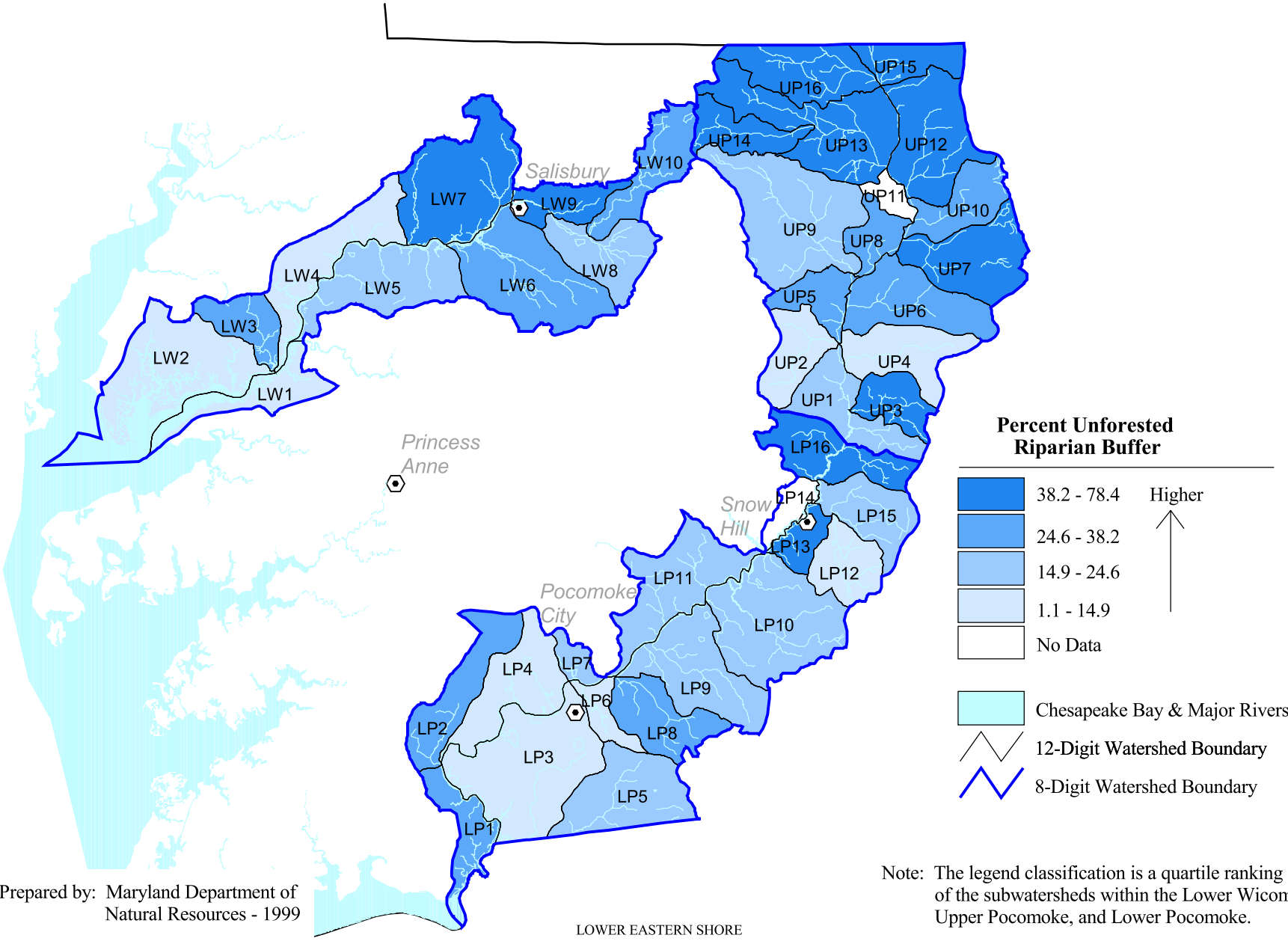
Nutrient Loading Composite



Percent Impervious Surface



Percent Unforested Riparian Buffer

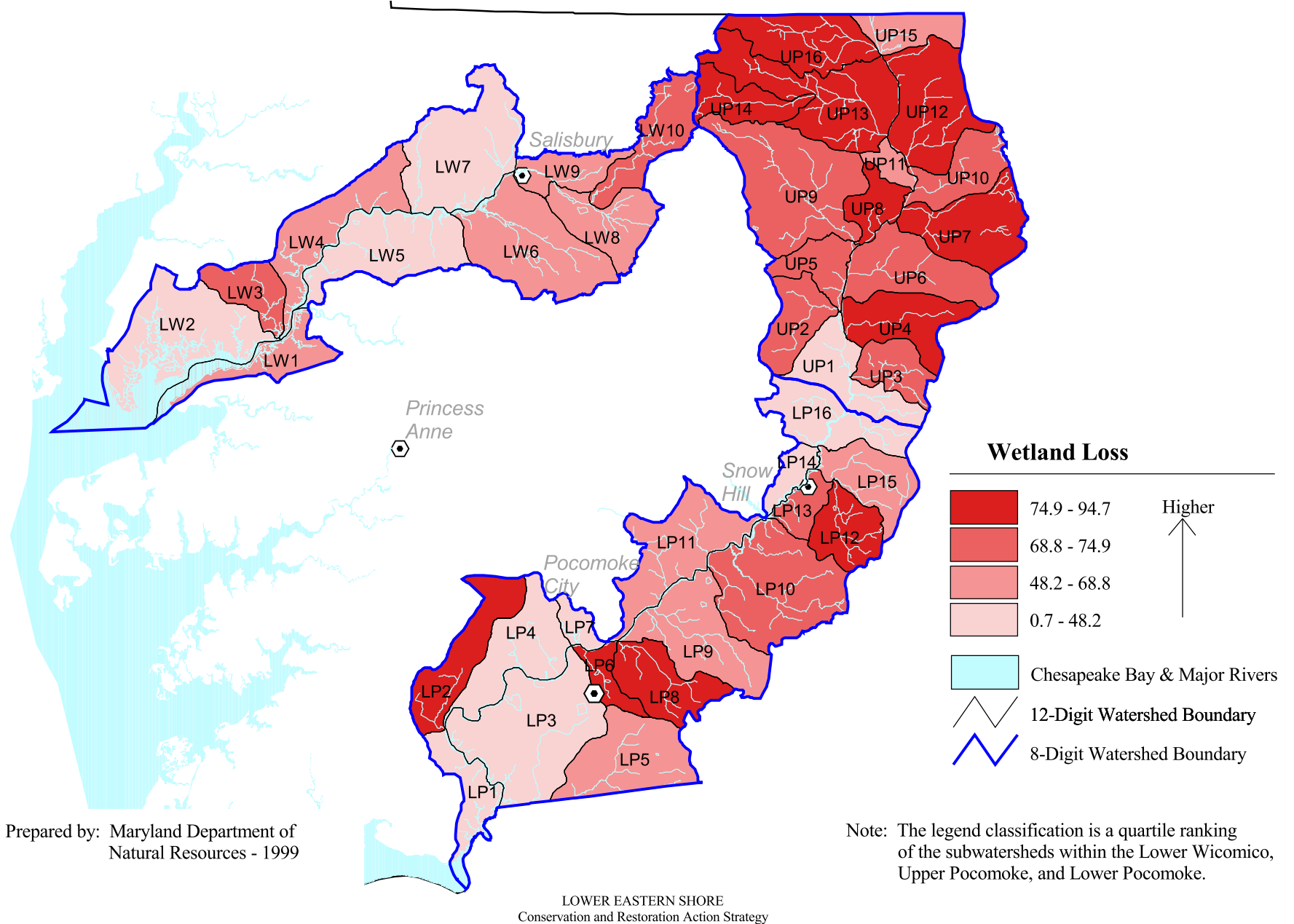


Prepared by: Maryland Department of Natural Resources - 1999

LOWER EASTERN SHORE
Conservation and Restoration Action Strategy

Note: The legend classification is a quartile ranking of the subwatersheds within the Lower Wicomico, Upper Pocomoke, and Lower Pocomoke.

Percent of Wetland Loss



Findings about Data

One issue raised by the Steering Committee in its first meeting has not been addressed at all in the preceding pages—the issue of monitoring and the availability of the data necessary to make appropriate decisions regarding watershed restoration.

This report has relied on the use of existing data to assess the condition of watersheds in the Lower Eastern Shore Tributary Basin, as did the Unified Watershed Assessment on a statewide scale. During the Lower Eastern Shore assessment, indicators derived from existing data were aligned with the issues or problems which had been identified by the Action Strategy Steering Committee. The tables that follow depict the alignment of issues, ecosystem assessment themes and available indicators. What is most evident from an examination of these tables is the significant mismatch between identified issues and the indicators available to assess the conditions and ecosystem stresses reflected in the issues. In two cases, there are no indicators for the theme at all; for another theme, no issues were raised by the Steering Committee.

Theme: Water Quality/Nonpoint Source Pollution

Even for themes where there are both issues and indicators, there is a lack of correspondence between the two in several cases. For example, despite years of gathering water quality data and modeling causes of pollution, Table 9 demonstrates that we have no indicator dealing with ground water contamination or the prevalence or magnitude of bacterial contamination of surface water. We have not developed an indicator for stream and shore erosion, although raw data probably exist to do this.

Table 9
Water Pollution Issues and Indicators

Issue		Indicators	
1.	Stormwater management	•	Nitrogen Loadings from the watershed to the Chesapeake Bay (Modeled)
2.	Animal waste management	•	Phosphorus Loadings from the watershed to the Chesapeake Bay (Modeled)
3.	Human waste management (mostly septic tanks)	•	Soil Erodibility
4.	Groundwater contamination	•	Animal Units
5.	Regulatory requirements for septic systems	•	Septic Systems
6.	Erosion and sediment control		
7.	Coliform bacteria		

Theme: Disruption to Hydrologic Processes

Hydrologic disruption is less studied than water quality degradation, as the relatively few indicators in Table 10 illustrate. It is also worth noting that the issues raised by the Steering Committee have no indicators available to assess either the prevalence or extent of the condition of concern. This is particularly a problem with respect to drainage ditches, seen by some as absolutely necessary to the maintenance of agriculture as a viable component of the economy and by others as a major conduit of nutrients from agricultural areas into natural water courses. These different perceptions will certainly have a role to play in the implementation of appropriate restoration actions.

Table 10
Hydrology Issues and Indicators

Issues		Indicators	
1.	Drainage ditches	•	Historic wetland loss
2.	Floodplains and the need to develop on them	•	Percent of impervious surface
		•	Permitted surface water withdrawals
		•	Permitted ground water withdrawals

Theme: Aquatic System

Although Table 11 demonstrates a better match of available indicators with the issues identified by the Steering Committee, the lack of an indicator for oysters is notable. *Pfiesteria* is a special case in which the comparative assessment of multiple watersheds, as carried out in this study, may not be appropriate or relevant. It is clearly a matter of major concern in the Lower Eastern Shore Basin, and statewide.

Table 11
Aquatic System Issues and Indicators

Issue		Indicators	
1.	Oyster population and health	•	Tidal water quality for habitat
2.	<i>Pfiesteria</i>	•	Tidal water quality—eutrophication
3.	SAV loss	•	Submerged Aquatic Vegetation habitat
4.	Stream buffers	•	Submerged Aquatic Vegetation health/abundance
		•	Migratory fish spawning index

Issue	Indicators
	<ul style="list-style-type: none"> • Unforested riparian bufferNon-tidal instream physical habitat • Non-tidal benthic Index of Biotic Integrity • Percent of headwater streams in core forest

Theme: Terrestrial System Degradation and Fragmentation

Perhaps because this study has been heavily focused on watershed restoration, relatively few issues were raised by the Steering Committee dealing with what is happening with the terrestrial system beyond what has a direct and evident impact on the aquatic system—those indicators we have included in the aquatic system. The growing awareness of how what is done on the land can impact water quality and aquatic living resources is only recently expanding to the scale of the greater landscape and its fragmentation.

Table 12
Terrestrial System Issues and Indicators

Issues	Indicators
<ol style="list-style-type: none"> 1. Forests 2. Wetland restoration 3. Management of State lands 	<ul style="list-style-type: none"> • % Watershed Land in Wetlands • % Watershed Land in Forest • Average Forest Patch Size • Forest Edge Density • Total Acres Interior Forest • % Land Area Protected for Natural Resource Use • Road Density • Population Density (1990)

Theme: Conservation of Biological Diversity

Interest in the conservation of Maryland’s biological diversity has been growing at the State level but was not reflected by the Steering Committee. Relatively few indicators are currently available at any scale to characterize the State’s biological diversity; this has been a problem in other arenas, also, such as the Environmental Performance Partnership process.

Table 13
Biodiversity Issues and Indicators

Issues	Indicators
None identified by Steering Committee	<ul style="list-style-type: none"> Wetlands of Special State Concern Sensitive Species Areas Imperiled Aquatic Species

Theme: Viability of Resource-based Industry

The Steering Committee placed emphasis on the region's economy when it brainstormed issues, both in general and with respect to particular sectors. Unfortunately few indicators currently exist that characterize the status of resource-based industries on a watershed basis. Aside from summarizing the location of specific recreational facilities and land conservation activities, most economic data currently available are summarized at the county level. Disaggregation of the data to watershed units is not statistically defensible or valid. Specifically, additional effort is needed to develop indicators for the forestry and seafood industries.

Table 14
Economy Issues and Indicators

Issues	Indicators
<ol style="list-style-type: none"> 1. Agricultural land preservation program 2. Tourism 3. Oysters 4. Public boat access 5. Access to marina pump-outs 6. Maintaining forestry 	<ul style="list-style-type: none"> Marina Slips Acres in Agricultural Easements

Unrepresented Themes

Two additional themes deriving from enunciated DNR goals were also reflected in issues raised by the Steering Committee as applicable to the Lower Eastern Shore. These themes and issues presently have no indicators related to them. Although raw data may be available from which to develop indicators, at least at the statewide level, certainly we are a long way from having the spatially distributed data needed to develop indicators at the watershed scale.

Table 15
Issues Without Indicators

Theme	Lower Eastern Shore Issues
Land and Resource Conservation at Local Levels	<ol style="list-style-type: none"> 1. Land use and its regulatory system 2. Property purchase to secure desired outcomes
Public Understanding and Community Support	<ol style="list-style-type: none"> 1. Lack of environmental organizations to participate as volunteers 2. Public education

Data and Scale

There is the additional problem of data resolution, as evidenced by the difficulty of finding indicators that could help in the selection of 12-digit watersheds in which to concentrate Phase II efforts. Even at the 8-digit scale, there are a number of assumptions that may impact the validity of using the indicators to focus conservation and restoration activities.

Summing Up—A Watershed Restoration Action Strategy for the Lower Eastern Shore

When DNR initiated this study we were hopeful that a concerted strategy involving many partners could be developed that would enable significant change in the several troubled watersheds in the Lower Eastern Shore Tributary Basin. Of six components that could together make up an action strategy, we have successfully achieved the first in Phase I and partially achieved another; three components are primarily the focus of the proposed Phase II work; one needs some retooling in Phase II; and one is not presently well integrated into the approach.

- Compiling information and making it available. This report documents in detail the first major component of a watershed action strategy for the Lower Eastern Shore—the compilation and distribution of geographic information presenting the ecosystem conditions and stresses found in the seventeen watersheds in the Basin. The conditions reflect, and the stresses contribute to, chemical, physical and biological degradation of the Chesapeake Bay, its tributary streams and their watersheds. The public and decision-makers in the Basin have never previously had this kind of information to consult when making decisions regarding actions that range from subdivision approvals to installation of agricultural best management practices to caring for septic systems to where to spend resources for data gathering.
- Involving partners. A Steering Committee made up of local government, agricultural, forestry, private-nonprofit, State and public interest representatives was established to oversee development of Phase I. This group has strong ties to the Tributary Strategy Team that has existed in the region for several years, charged with developing strategies

to achieve and maintain reductions in nutrients entering the Bay and its tributaries; its ties back into the larger community were less strong, in part because the effort did not originate at the local level as a response to locally-perceived needs. As the project moves into Phase II, a more technically based implementation committee, including some members of the Steering Committee, will oversee field exploration and the determination of specific actions needed. A first and necessary step in Phase II will be to reach interested individuals in very localized areas who might wish to pursue restoration actions.

- Establishing Maximum Daily Loads (TMDLs) and other goals and milestones. The Maryland Department of Environment (MDE) is charged with developing regulations affecting both point and nonpoint sources of pollution, using calculations of maximum allowable loadings of particular pollutants—TMDLs. Because of different mandates driving TMDLs and watershed restoration action strategies, MDE's priorities for timing development of TMDLs are not always developed in accordance with the Unified Watershed Assessment's identification of need for restoration. In the case of the Lower Eastern Shore, TMDL's are not yet available to assist in developing an action strategy, although discussions have taken place between DNR and MDE staff on how to integrate TMDLs with ongoing Action Strategy work. For the three focus watersheds in the Lower Eastern Shore Basin identified by the Steering Committee, TMDLs are currently expected to be completed for the Wicomico River in early- to mid-2000 and for the Pocomoke River by late 2000. Other milestones and the schedules for attaining them will be included in particular project plans as they are developed in Phase II.
- Identifying priority project areas. GIS-based watershed assessment tools developed by DNR were used to identify priority areas to begin the more intensive and specific Phase II. GIS-based targeting tools and field investigation will be used to identify areas for a variety of restoration projects. Specific data used to develop biological indicators may prove particularly valuable when individual streams are identified—data that are more relevant at this scale than for the larger watershed. Targeting tools that will play a role, depending upon the nature of the particular problems, include those for establishing riparian forest buffers and for re-establishing and enhancing wetlands. The Green Infrastructure methodology developed by DNR will also help to expand the effort beyond restoration to conservation and help to link the two.
- Implementing specific projects in priority areas It is important to get a few small scale projects under way quickly to demonstrate the range of actions both available and needed for watershed restoration. Additional projects will be proposed as Phase II progresses, and funding needs to handle them will be identified.
- Improving monitoring and data acquisition. Existing monitoring resources can be better targeted both to fill information gaps that have been identified and to help evaluate the effects of restoration actions, through both pre- and post-installation sampling and analysis. Revised monitoring protocols now being completed by DNR will allow for this targeted monitoring, in addition to continuing statewide random-sample monitoring.

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